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ABSTRACT

This curriculum guide is designed for group instruction of secondary agricultural education students enrolled in one or two semester-long courses in agricultural metal working. The guide presents units of study in the following areas: (1) oxyacetylene welding, (2) arc welding, (3) sheet metal, (4) blueprint reading for welders and (5) job opportunities in agricultural metals. Each of the twelve units of instruction follows a typical format: terminal objective, specific objectives, suggested instructor and student activities, instructional materials, information sheet, transparency masters, assignment sheets, and a student test. (LRA)

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AGRICULTURE EDUCATION

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AGRICULTURAL

METAL

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CE 023770

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PREFACE

This curriculum guide is a suggested method of group instruction for students enrolled in one or two semester-long courses in Agriculture Education.

This material is intended to cover those items which a student will most likely encounter when employed in this given area of agriculture.

Individualized instructional material should be supplemented to this curriculum guide to meet individual and local needs.

This curriculum guide contained herein was performed pursuant to a contract with the Exemplary Section, Division of Vocational, Technical and Adult Education, Arkansas Department of Education.

ACKNOWLEDGEMENT

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Unit I Job Opportunities in Ag Metals

OXYACETYLENE WELDING

UNIT I

SECTION A

OXYACETYLENE WELDING

TERMINAL OBJECTIVE

After completion of this unit, the student should have a general knowledge of oxyacetylene welding. The student will be able to assemble, light and shut off a torch. This knowledge will be evidenced through demonstration and by scoring at least eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

I. Match terms associated with oxyacetylene welding.

II. List ten safety rules concerning oxyacetylene equipment.

III. State or describe the characteristics of oxygen and acetylene.

IV. Name ten components of an oxyacetylene welding outfit.

V. State the three components of the fire triangle.

VI. Set up to the satisfation of the instructor, an oxyacetylene welding outfit.

VII. List the four steps in lighting a torch.

VIII. List the steps used to turn off a torch.

IX. Describe the three types of flames.

OXYACETYLENE WELDING

SUGGESTED ACTIVITIES

I. Instructor:

   A. Provide students with objective sheet.

   B. Provide students with information and job sheets.

   C. Make transparencies.

   D. Discuss terminal and specific objectives.

   E. Discuss information sheet.

   F. Demonstrate and discuss procedures outlined in job sheets.

   G. Give test.

II. Student:

   A. Read objectives.

   B. Study information sheet.

   C. Demonstrate the ability to accomplish the procedures outlined in the job sheet.

   D. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

   A. Objectives

   B. Information sheets

   C. Transparency masters

      1. TM 1 - The Fire Triangle

      2. TM 2 - Oxyacetylene Welding Equipment

      3. TM 3 - Welding Regulators

      4. TM 4 - Oxyacetylene Cutting Flames

D. Test

E. Answers to test

II. References:

A. Parker, Marvin M., Farm Welding, New York, McGraw Hill Book Co.

B. Griffin, Ivan H. and Roden, Edward M., Welding Processes, Albany, New York, Delmar Publishers.

C. Jones, Mack M., Shopwork On The Farm, New York, McGraw Hill Book Co.

D. Althouse, A.D. and Turnquist, C.H., Modern Welding, South Holland, Illinois, Goodheart Wilcox Co.

E. Wakeman, T.J. and McCoy, Vernon Lee, The Farm Shop, The McMillan Co.

F. Mid American Curriculum Consorcium.

OXYACETYLENE WELDING

INFORMATION SHEET

I. Terms and defintions:

A. OXYGEN - Colorless, odorless gas which supports burning.

B. ACETYLENE - Gas composed of two parts carbon and one part hydrogen.

C. OXIDATION - Oxygen combining with any other substance.

D. OXIDIZING FLAME - Flame produced by an excess of oxygen in the torch mixture, leaving some free oxygen to oxidize.

E. NEUTRAL FLAME - Flame which results from combination of perfect proportions of oxygen and the welding gas.

F. CARBUREZING FLAME - An oxygen-fuel gas flame with a slight excess of the fuel gas.

G. BACKFIRE - A short "pop" of the torch flame followed by extinguishing of the flame or continued burning of the gases.

H. FLASHBACK - Fire burning inside torch.

II. Safety rules concerning oxyacetylene equipment:

A. Never drop cylinders or permit them to be struck violently.

B. Never store cylinders near a heat source.

C. Secure cylinders while in use.

D. Never store or move cylinders without protective caps on.

E. Keep open flame away from cylinder.

F. Always keep acetylene cylinder wrench in place when using.

INFORMATION SHEET

G. Do not attempt to alter or repair cylinders, valves or safety devices.

H. Always use pressure reducing regulators.

I. Always wear goggles when welding or cutting.

J. Never set acetylene regulator at over 15 pounds pressure.

K. Do not open acetylene cylinder valve more than one turn.

L. Fully open oxygen cylinder valve when the cylinder is in use.

M. Acetylene cylinders should be used and stored in an upright position.

N. Always weld in well ventilated area.

O. Never weld or cut closed containers which have held gasoline, oil or other combustible materials.

III. Characteristics of gases:

A. Oxygen

1. Colorless
2. Odorless
3. Tasteless
4. Supports and intensifies flame

B. Acetylene

1. Colorless
2. Has distinct odor
3. Combustible

IV. Parts of oxyacetylene equipment:

A. Oxygen tank

B. Oxygen regulator

C. Oxygen and acetylene hose

INFORMATION SHEET

D. Acetylene tank

E. Acetylene regulator

F. Cylinder truck

G. Safety chain

H. Acetylene fittings

I. Oxygen fitting

J. Welding goggles

K. Welding gloves

L. Acetylene tank wrench

M. Torch body

N. Torch or welding tips

O. Cutting attachments

V. Three components of the fire triangle:

A. FUEL - Any combustible material.

B. HEAT - Enough to raise the fuel to its ignition temperature.

C. OXYGEN - Necessary to sustain combustion.

VI. Steps in setting up oxyacetylene welding equipment:

A. Secure tanks to cart with safety chains.

B. Remove safety caps from tanks.

C. Open oxygen cylinder valve for an instant to blow out dust.

CAUTION: Do not stand in front of valve.

D. Open acetylene cylinder valve for an instant to blow out dust.

E. Attach oxygen regulator to oxygen cylinder. (Right hand threads)

INFORMATION SHEET

F. Attach acetylene regulator to acetylene cylinder. (Left hand threads. Draw connection nuts up firmly, do not force them.)

G. Connect red hose to acetylene regulator. (Left hand threads)

H. Connect green hose to oxygen regulator. (Right hand threads)

I. Before turning on gases, release pressure on regulator by turning adjusting screw to left.

J. Open oxygen tank valve completely.

K. Open acetylene tank valve not over ½ turn.

L. Use gases to blow dust particles from hose. (To do this, open each regulator by turning the adjusting screw to right, allowing gas flow for an instant, then turn regulator screw to left to stop gas flow.)

M. Connect green hose to oxygen connection on torch.

N. Connect red hose to acetylene connection on torch.

O. Select proper welding tip.

P. Adjust proper gas pressures.

Q. Check for leaks with soapy water.

VII. Four steps in lighting a torch:

A. Turn acetylene needle valve ¼ turn.

B. Light with spark lighter.

C. Open acetylene needle valve until black soot disappears.

D. Open oxygen needle valve until outer cone disappears. (This is a neutral flame. See transparency)

VIII. Steps used to turn off a torch:

A. Close acetylene valve.

B. Close oxygen valve.

INFORMATION SHEET

C. Close oxygen and acetylene tank valve.

D. Open acetylene needle valve.

E. Release acetylene regulator pressure by turning adjusting screw to the left.

F. Close torch acetylene needle valve.

G. Open oxygen needle valve.

H. Release oxygen regulator pressure by turning adjusting screw to the left.

IX. Three types of flames:

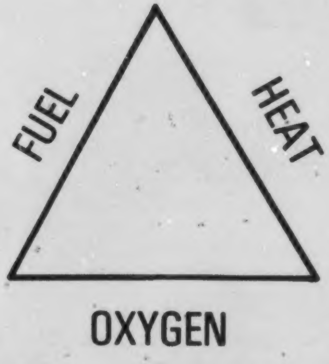
A. Oxidizing - When an excess of oxygen is used. (Characterized by a sharp, pointed, hissing flame.)

B. Carburezing - When an excess of acetylene is used.

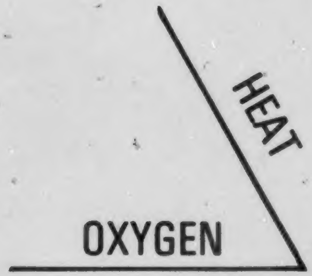
C. Neutral - Burns equal amounts of oxygen and acetylene.

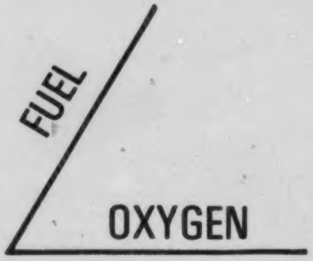
The Fire Triangle

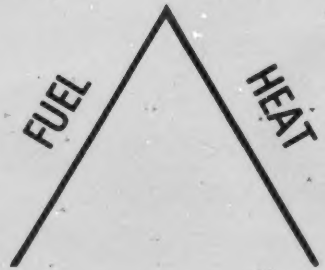
To produce fire, three things must be present at the same time.


FUEL
HEAT
OXYGEN

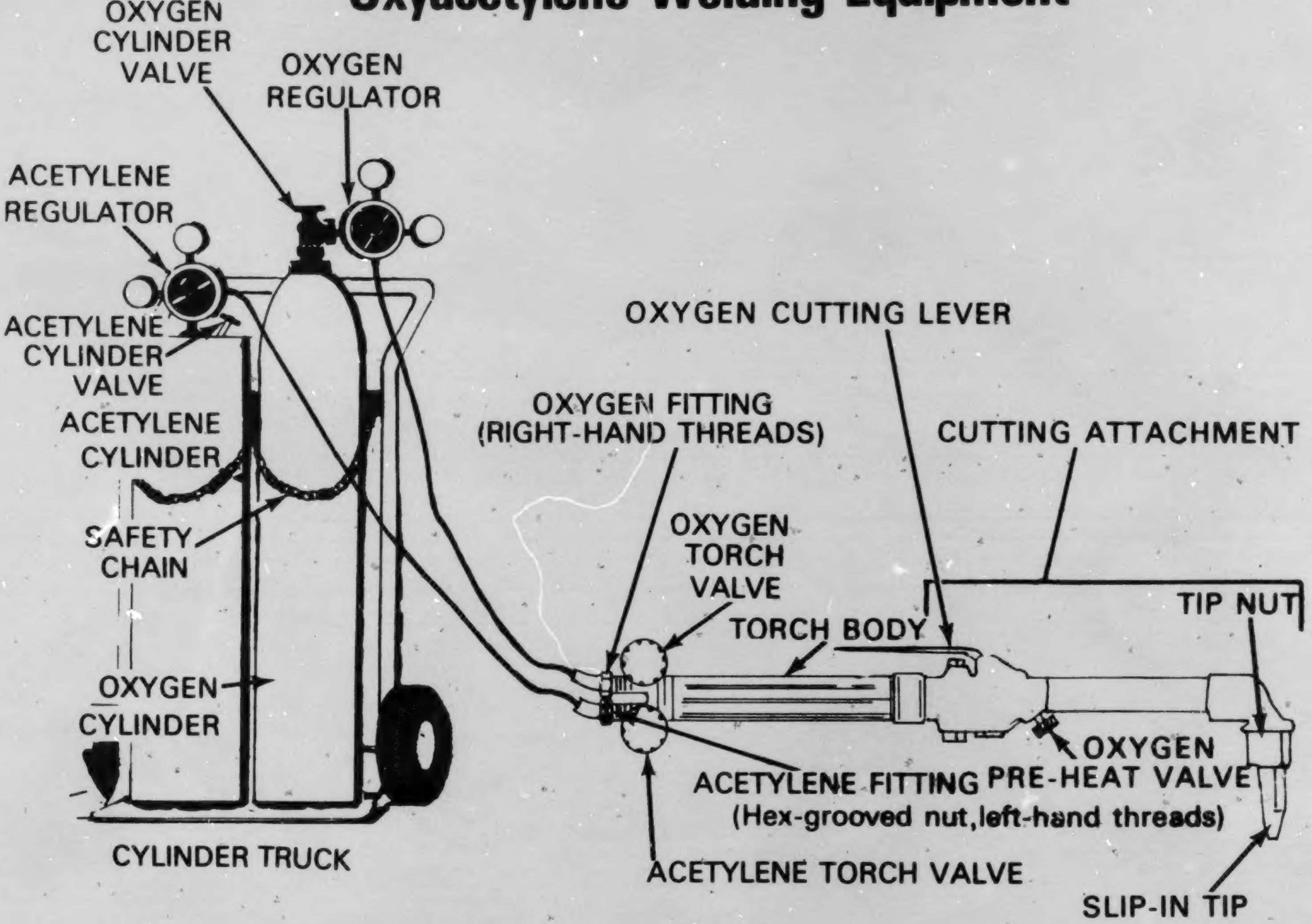
If any one of the three is missing, a fire cannot be started or, with the removal of any one, the fire will be extinguished.


HEAT
OXYGEN


FUEL
OXYGEN

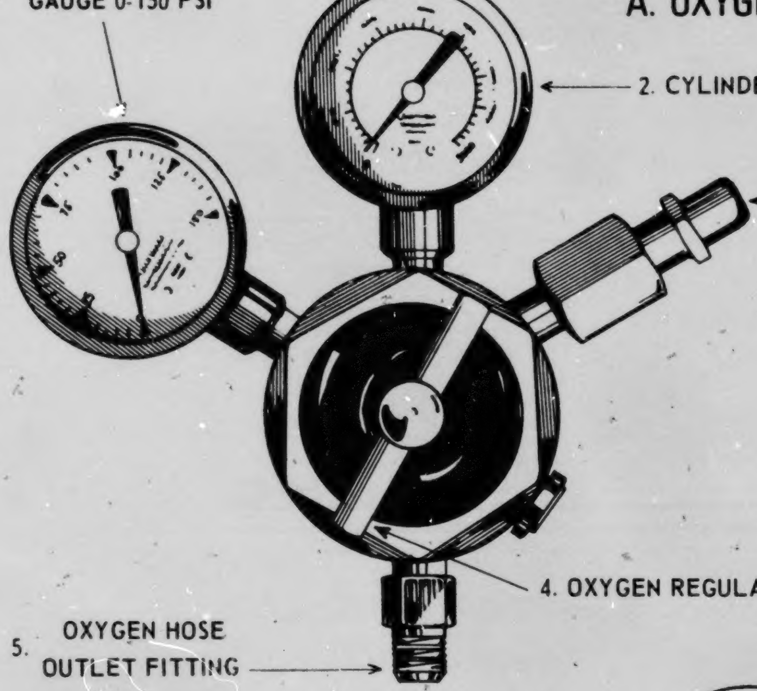


Oxyacetylene Welding Equipment

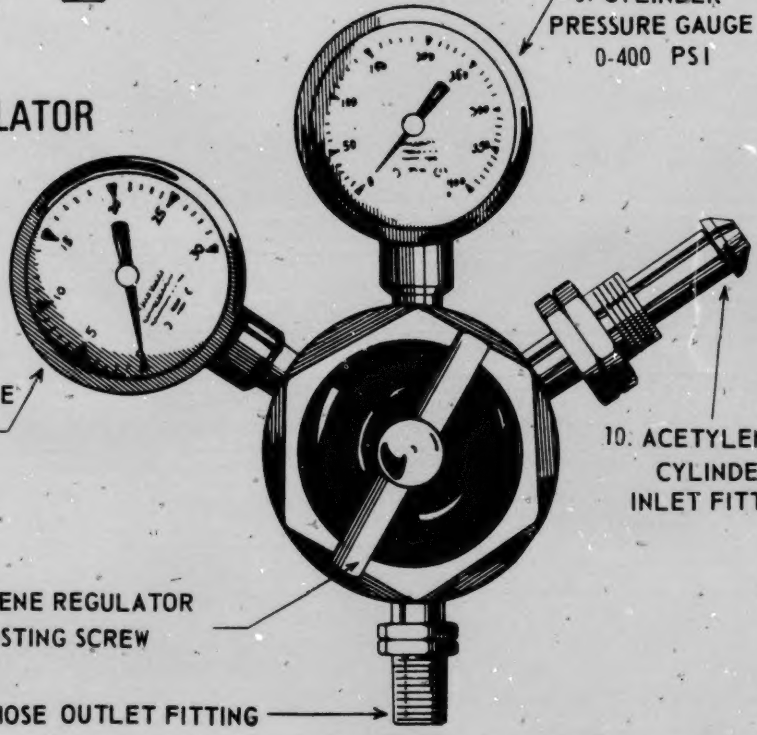

OXYGEN CYLINDER VALVE
OXYGEN REGULATOR
ACETYLENE REGULATOR
ACETYLENE CYLINDER VALVE
ACETYLENE CYLINDER
SAFETY CHAIN
OXYGEN CYLINDER
CYLINDER TRUCK
OXYGEN CUTTING LEVER
OXYGEN FITTING (RIGHT-HAND THREADS)
CUTTING ATTACHMENT
OXYGEN TORCH VALVE
TORCH BODY
TIP NUT
OXYGEN PRE-HEAT VALVE
ACETYLENE FITTING (Hex-grooved nut, left-hand threads)
ACETYLENE TORCH VALVE
SLIP-IN TIP

Welding Regulators

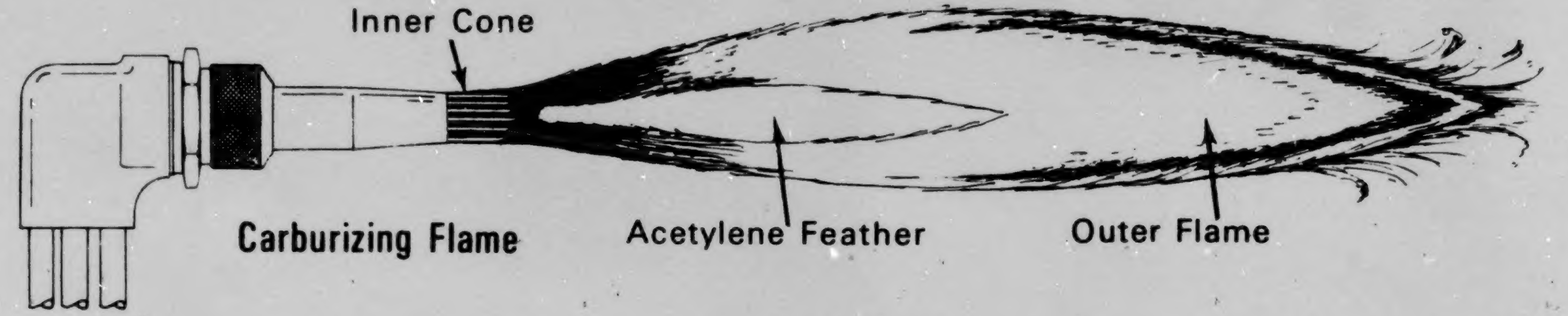
A. OXYGEN REGULATOR GAUGES


1. WORKING PRESSURE GAUGE 0-150 PSI
2. CYLINDER PRESSURE GAUGE 0 to 3000 PSI
3. OXYGEN CYLINDER INLET FITTING
4. OXYGEN REGULATOR ADJUSTING SCREW
5. OXYGEN HOSE OUTLET FITTING

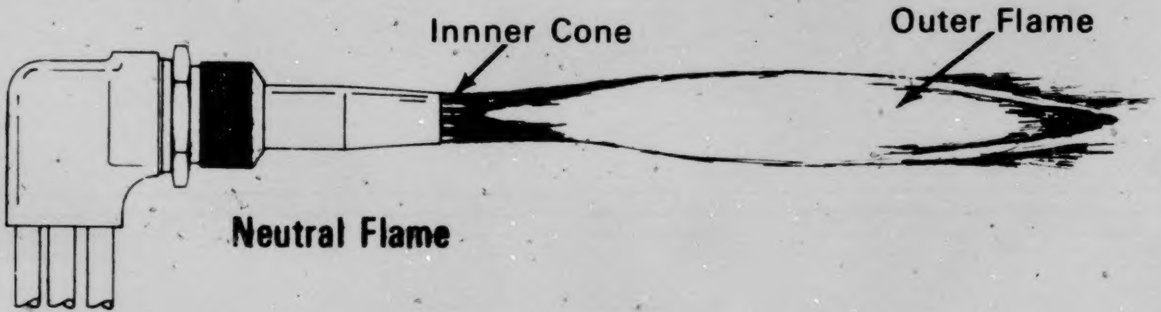
B. ACETYLENE REGULATOR


6. CYLINDER PRESSURE GAUGE 0-400 PSI
7. WORKING PRESSURE GAUGE 0 TO 30 PSI
8. ACETYLENE REGULATOR ADJUSTING SCREW
9. ACETYLENE HOSE OUTLET FITTING
10. ACETYLENE CYLINDER INLET FITTING

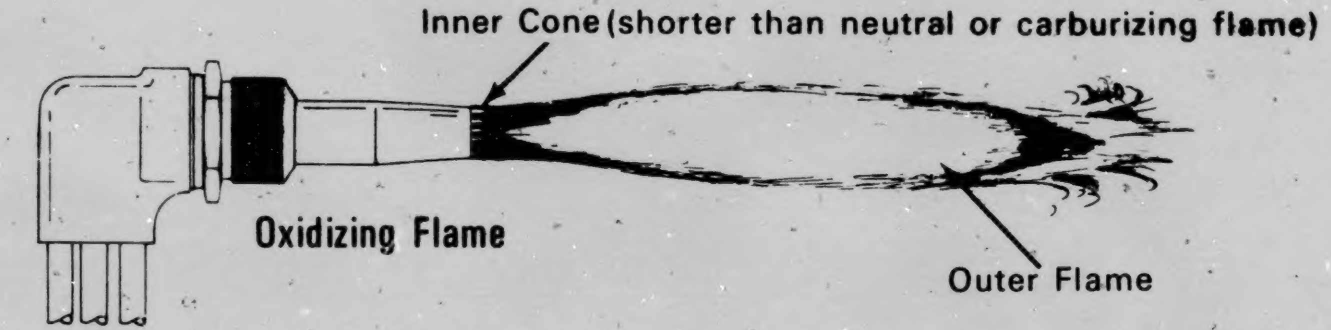
Oxyacetylene Cutting Flames


Inner Cone
Acetylene Feather
Outer Flame

Carburizing Flame


Innner Cone
Outer Flame

Neutral Flame


Inner Cone (shorter than neutral or carburizing flame)
Outer Flame

Oxidizing Flame

OXYACETYLENE WELDING

TEST

I. Match terms associated with oxyacetylene welding to the correct definition.

___A. Colorless, odorless gas which supports burning.

___B. Flame which results from combination of perfect proportions of oxygen and the welding gas.

___C. Fire burning inside torch.

___D. An oxygen-fuel gas flame with a slight excess of the fuel gas.

___E. Oxygen combining with any other substance.

___F. Flame produced by an excess of oxygen in the torch mixture, leaving some free oxygen to oxidize.

___G. Gas composed of two parts carbon and one part hydrogen.

___H. A short "pop" of the torch flame followed by extinguishing of the flame or continued burning of the gases.

1. Carburezing Flame
2. Oxidation
3. Acetylene
4. Backfire
5. Oxygen
6. Neutral Flame
7. Oxidizing Flame
8. Flashback

II. List ten safety rules concerning oxyacetylene equipment.

A.

B.

C.

D.

E.

F.

G.

H.

I.

J.

III. State or describe characteristics of the following:

A. Oxygen-

B. Acetylene-

IV. Name ten components of an oxyacetylene welding outfit.

A.

B.

C.

D.

E.

F.

G.

H.

I.

J.

V. State the three components of the fire triangle.

A.

B.

C.

VI. Demonstrate to the instructor the proper way to set up a welding outfit.

VII. List the four steps in lighting a torch.

A.

B.

C.

D.

VIII. List the steps used to turn off a torch.

A.

B.

C.

D.

E.

F.

G.

H.

IX. Describe the following three types of flames.

A. Oxidizing-

B. Carburezing-

C. Neutral-

OXYACETYLENE WELDING

ANSWERS TO TEST

I. A. 5

B. 6

C. 8

D. 1

E. 2

F. 7

G. 3

H. 4

II. Any ten of the following:

A. Never drop cylinders or permit them to be struck violently.

B. Never store cylinders near a heat source.

C. Secure cylinders while in use.

D. Never store or move cylinders without protective caps on.

E. Keep open flame away from cylinder.

F. Always keep acetylene cylinder wrench in place when using.

G. Do not attempt to alter or repair cylinders, valves or safety devices.

H. Always use pressure reducing regulators.

I. Always wear goggles when welding or cutting.

J. Never set acetylene regulator over 15 lbs. pressure.

K. Do not open acetylene cylinder valve more than one turn.

L. Fully open oxygen cylinder valve when the cylinder is in use.

M. Acetylene cylinders should be used and stored in an upright position.

N. Always weld in well ventilated area.

O. Never weld or cut closed containers which have held gasoline, oil or other combustible materials.

III. A. Oxygen-

1. Colorless
2. Odorless
3. Tasteless
4. Supports and intensifies burning

B. Acetylene-

1. Colorless
2. Has distinct odor
3. Combustible

IV. Any ten of the following:

A. Oxygen tank

B. Oxygen regulator

C. Oxygen and acetylene hose

D. Acetylene tank

E. Acetylene regulator

F. Cylinder truck

G. Safety chain

H. Acetylene fittings

I. Oxygen fitting

J. Welding goggles

K. Welding gloves

L. Acetylene tank wrench

M. Torch body

N. Torch or welding tips

O. Cutting attachments

V. A. Fire

B. Heat

C. Oxygen

VI. To the satisfaction of the instructor.

VII. A. Turn acetylene needle valve ¼ turn.

B. Light with spark lighter.

C. Open acetylene needle valve until black soot disappears.

D. Open oxygen needle valve until outer cone disappears. (This is a neutral flame.)

VIII. A. Close acetylene valve first.

B. Close oxygen valve.

C. Close oxygen and acetylene tank valve.

D. Open acetylene needle valve.

E. Release acetylene regulator pressure by turning adjusting screw to the left.

F. Close torch acetylene needle valve.

G. Open oxygen needle valve.

H. Release oxygen regulator pressure by turning adjusting screw to the left.

IX. A. Oxidizing - When an excess of oxygen is used. (Characterized by a sharp, pointed, hissing flame.)

B. Carburezing - When an excess of acetylene is used.

C. Neutral - Burns equal amounts of oxygen and acetylene.

POSITION WELDING

UNIT II

SECTION A

POSITION WELDING

TERMINAL OBJECTIVE

After completion of this unit, the student should be able to weld with the oxyacetylene welding equipment on any type mild steel or cast iron in any position.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

I. Define six terms associated with oxyacetylene welding.

II. Name five factors that determine weld quality.

III. List three factors that determine tip selection.

IV. Name two factors that determine rod selection.

V. Name three types of flames.

VI. Demonstrate the ability to:

- A. Run puddle without rod
- B. Run puddle with rod
- C. Fusion weld without rod
- D. Butt weld with steel rod
- E. Run beads in vertical position with rod
- F. Lap weld in light steel
- G. Lap weld in heavy plate
- H. Backhand welding on heavy plate
- I. Backhand welding of leveled butt joint
- J. Running beads with bronze rod
- K. Brazed butt joint on light steel
- L. Brazed lap joint

M. Brazed fillet joint

N. Brazing heavy steel plate

O. Brazing cast iron

POSITION WELDING

SUGGESTED ACTIVITIES

I. Instructor:

  A. Provide students with objective sheets.

  B. Provide students with information and job sheets.

  C. Discuss terminal and specific objectives.

  D. Discuss information sheets.

  E. Demonstrate and discuss procedures in the job sheets.

  F. Give test.

II. Students:

  A. Read objective sheets.

  B. Study information sheets.

  C. Demonstrate the ability to accomplish the procedures outlined in the job sheets.

  D. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

  A. Objectives

  B. Information sheets

  C. Job sheets

    1. Job sheet #1 - Running Puddle Without Rod

    2. Job sheet #2 - Running Puddle With Rod

    3. Job sheet #3 - Fusion Weld Without Rod

    4. Job sheet #4 - Butt Weld With Steel Rod

    5. Job sheet #5 - Run Beads in Vertical Position With Rod

6. Job sheet #6 - Lap Weld in Light Steel
7. Job sheet #7 - Lap Weld in Heavy Plate
8. Job sheet #8 - Backhand Welding in Heavy Plate
9. Job sheet #9 - Backhand Welding of Leveled Butt Joint
10. Job sheet #10- Running Beads With Bronze Rod
11. Job sheet #11- Brazed Butt Joint on Light Steel
12. Job sheet #12- Brazed Lap Joint
13. Job sheet #13- Brazed Fillet Joint
14. Job sheet #14- Brazing Heavy Steel Plate
15. Job sheet #15- Brazing Cast Iron

D. Test

E. Answers to test

II. References:

A. Griffin, Ivan H. and Roden, Edward M., Welding Processes, Albany,New York, Delmar Publishers.

B. Parker, Marvin M., Farm Welding, New York, New York, McGraw Hill Book Co.

C. Wakeman, T.J. and McCoy, Vernon, The Farm Shop, New York, New York, The MacMillan Co.

POSITION WELDING

INFORMATION SHEET

I. Terms and definitions:

- A. PENETRATION - Extent the fusion goes into the base metal as measured from the surface of the base metal.
- B. FUSION - Intimate mixing of molten metals.
- C. BASE METAL - Metal to be welded, cut or brazed.
- D. NEUTRAL FLAME - Flame resulting from combustion.
- E. EXCESS OXYGEN FLAME - When extra oxygen is turned on after a neutral flame has been produced.
- F. EXCESS ACETYLENE FLAME - When a visible feathery outer cone is present exceeding the length of the inner cone.
- G. TACK WELD - Small weld used to temporarily hold together components of an assembly.
- H. INNER CONE - The cone shaped, white inner flame of a neutral or near neutral flame.
- I. BRAZE WELDING - Making a flame adhesion connection with a brazing alloy.

II. Factors that determine weld quality.

- A. Proper flame adjustment
- B. Angle of tip
- C. Distance from work
- D. Speed of travel
- E. Movement of tip

III. Factors that determine tip selection.

- A. Metal thickness
- B. Size of welding rod
- C. Type of weld desired

INFORMATION SHEET

IV. Factors that determine rod selection.

- A. Type of metal to be welded
- B. Thickness of metal

V. Types of flames and thier uses.

- A. Neutral flame
    1. Perfect blend of oxygen and acetylene.
    2. Produced by adjusting oxygen until outer cone disappears.
    3. Used for most types of welding.
    4. Flame temperature of 5950°.
    5. Identified by clear, well defined white cone.
- B. Carburezing flame
    1. Produced by failure to turn on enough oxygen to produce neutral flame.
    2. Has a visible acetylene feather.
    3. Used for cutting cast iron.
    4. Produced weak welds.
- C. Oxidizing flame
    1. Produced by turning on extra oxygen after neutral flame has been achieved.
    2. Identified by a short inner cone.
    3. Causes metal to become brittle because of oxidation.
    4. Used in some type of brazing.

POSITION WELDING

JOB SHEET #1 - RUNNING PUDDLE WITHOUT ROD

I. Tools needed:

A. Goggles, welding

B. Gloves

C. Pliers

D. Oxyacetylene welding outfit

E. Center punch

F. Ball pien hammer

G. Wire brush

H. C Clamp

I. Welding table

J. Clear goggles

II. Material needed:

A. 1/8" X 2" to 4" X 6" to 9" long

B. Smith No. 5 welding tip or equivalent

III. Procedure

A. Clean metal for welding and clamp to welding table.

B. With center punch mark off straight lines on metal.

C. Adjust pressure to 5 lbs. each for oxygen and acetylene.

D. Light torch and adjust to neutral flame.

E. Hold the tip of the inner cone of the flame 1/8" above the work.

F. Point flame in the exact direction in which weld is to proceed.

G. Flame should make an angle of 45° to 60° with the work.

H. Hold the flame in one spot until a puddle of metal ¼" to 3/8" in diameter is formed.

JOB SHEET #1

I. Proceed with weld, advancing flame at a uniform speed to keep the puddle the same diameter at all times.

J. The finished bead should be approximately 6 times as wide as metal is thick.

K. Examine completed weld for uniformity and smoothness.

L. Check underside of metal for penetration. (Should show a slight bulge or ripple on underside.)

M. Continue running beads parallel to the original bead.

N. When a good bead has been accomplished, turn in to the instructor for grade.

POSITION WELDING

JOB SHEET #2 - RUNNING PUDDLE WITH ROD

I. Tools and equipment needed:

   A. Goggles, welding

   B. Gloves

   C. Pliers

   D. Oxyacetylene welding outfit

   E. Center punch

   F. Wire brush

   G. Ball pien hammer

   H. C Clamp

   I. Welding table

   J. Clear goggles

II. Material needed:

   A. 1/8" X 2" to 4" X 6" to 9"

   B. Smith No. 5 welding tip or equivalent

   C. 3/32" steel rods

III. Procedure:

   A. Clean metal for welding.

   B. With center punch, mark off straight lines on metal.

   C. Adjust pressure to 5 lbs, on both oxygen and acetylene.

   D. Light torch and adjust to neutral flame.

   E. Hold flame approximately 1/8" above metal to be welded and angle as shown in diagram.

   F. Melt puddle at one end of plate to desired size. (6 times as wide as metal is thick.)

JOB SHEET #2

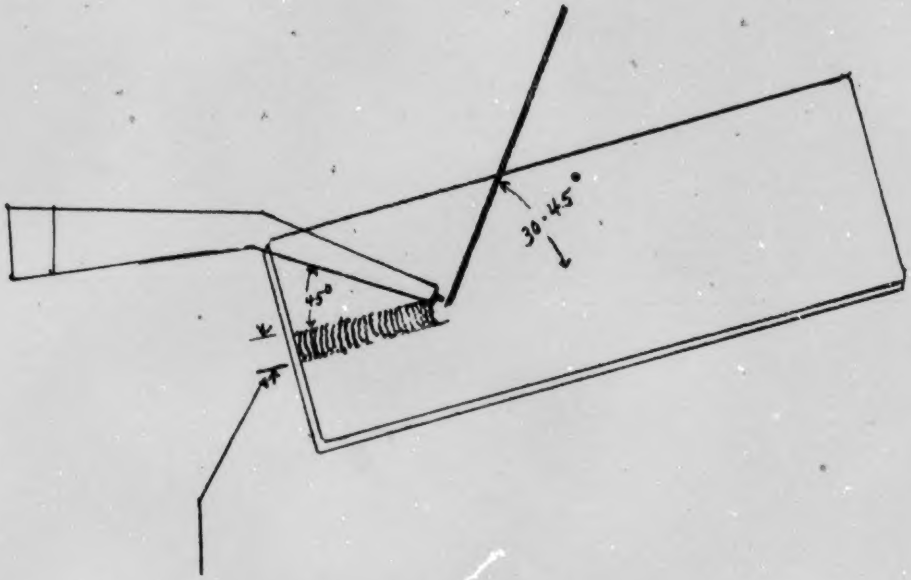
G. Place welding rod in puddle and proceed across metal at a rate to produce a good uniform bead.

H. Be sure to hold rod and flame at proper angle.

I. Bead produced should be as wide as puddle, smooth and relatively flat.

J. Make more welds in this manner until a good bead is produced.

K. Turn in to instructor for grade.



APPROXIMATELY SIX TIMES THICKNESS OF METAL

POSITION WELDING

JOB SHEET #3 - FUSION WELD

I. Tools needed:

A. Goggles, welding

B. Gloves

C. Pliers

D. Oxyacetylene welding outfit

E. Wire brush

F. Welding table

G. Clear goggles

II. Materials needed:

A. 2 pieces of 1/8" metal 2" X 6".

B. Smith No. 5 welding tip or equivalent.

III. Procedure:

A. Clean metal for welding.

B. Set up metal as illustrated in diagram A at end of job sheet.

C. Adjust pressure to 5 lbs. on both oxygen and acetylene.

D. Light torch and adjust to neutral flame.

E. Hold torch as shown in diagram.

F. Hold tip of flame 1/8" above metal and move in circular motion at edge of metal until puddle is formed.

G. Keep puddle in front of flame and proceed along length of weld.

H. Check underside of weld for penetration. This should appear as a slight ridge in underside of joint.

I. Finished weld should have a smooth, slightly rippled appearance on top with good penetration.

JOB SHEET #3

J. Continue making this type of weld until satisfactory bead and penetration is accomplished.

K. Turn in to instructor for grade.

DIAGRAM A

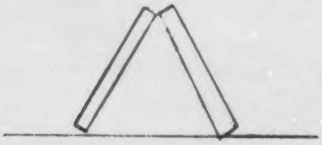
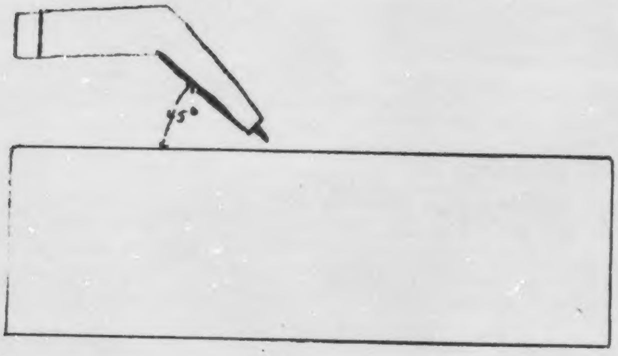


DIAGRAM B



POSITION WELDING

JOB SHEET #4 - MAKING BUTT WELD WITH STEEL ROD

I. Tools needed:

- A. Goggles, welding
- B. Gloves
- C. Pliers
- D. Oxyacetylene welding outfit
- E. Wire brush
- F. C Clamp
- G. Welding table
- H. Clear goggles

II. Materials needed:

- A. Two pieces of approximatley 1/8" thick 1½" X 6" mild steel
- B. 3/32" steel welding rod
- C. Smith No. 5 welding tip or equivalent

III. Procedure:

- A. Clean metal for welding.
- B. Place metal pieces on welding table approximately 1/8" apart.
- C. Adjust oxygen and acetylene pressure to 5 lbs. each.
- D. Tack weld pieces, as shown in diagram, every 2".
- E. Use same procedure for weld as in job sheet #2 except the weld must be straight and centered on the joint between pieces.
- F. On thin metal, complete penetration should be achieved from one side. This can be accomplished if bead is six times as wide as metal is thick.

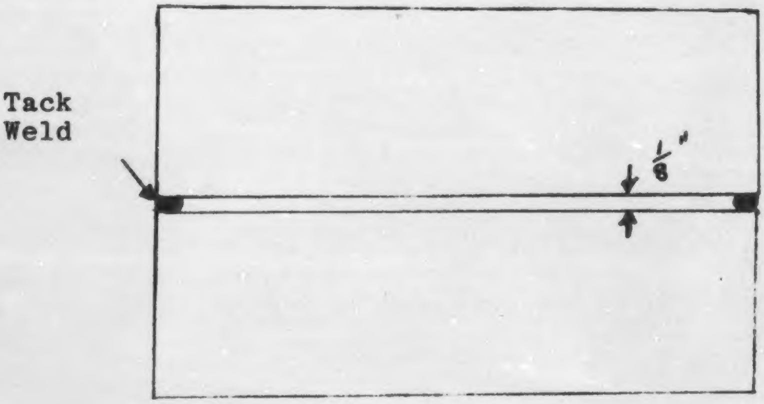
JOB SHEET #4

G. After completion of bead, check underside of weld for penetration.

H. Test weld by placing in use or weld tester and bend toward face of weld. With a good bead you should be able to bend to a 90° angle without weld breaking or pulling loose. (Face of weld is side on which weld is made.)

I. Continue making butt welds until satisfactory beads with good penetration are produced.

J. Turn in to instructor for grade.



POSITION WELDING

JOB SHEET #5 - RUNNING BEADS IN VERTICAL POSITION WITH ROD

I. Tools needed:

A. Goggles, welding

B. Gloves

C. Pliers

D. Oxyacetylene welding outfit

E. Center punch

F. Ball pien hammer

G. Wire brush

H. C Clamp

I. Welding table

J. Clear goggles

II. Materials needed:

A. 1 1/8" mild steel plate 6" X 12"

B. 1 1/8 " mild steel plate 6" X 6"

C. Smith No. 5 welding tip

D. 3/32" steel welding rods

III. Procedure:

A. Clean metal for welding.

B. With center punch, mark 5 lines on large piece of metal one inch apart and 12" long. (See diagram A)

C. Adjust oxygen and acetylene pressure to 5 lbs. each.

D. Tack weld large plate to smaller plate as shown in diagram B.

E. Hold torch and rod in position shown in diagram C at bottom edge of plate.

JOB SHEET #5

F. Hold torch in one position until a puddle is formed.

G. Add metal from rod until desired size bead is formed.

H. Move upward at a slow, constant speed and add metal to the weld in the same manner as in flat position.

I. Lift flame upward at regular intervals if necessary to allow the lower edge of puddle to solidify.

J. Points to remember about welding in vertical position:

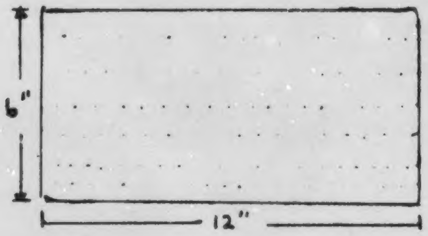
    A. Always hold torch and welding rod in correct position.

    B. Weld with shallow puddle.

    C. Move flame upward at regular intervals to allow lower edge of puddle to solidify.

K. When satisfactory bead has been accomplished, turn work in to instructor for grade.

DIAGRAM A



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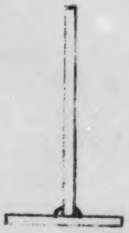
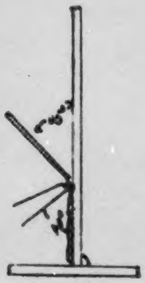


DIAGRAM C



POSITION WELDING

JOB SHEET #6 - LAP WELD IN LIGHT STEEL

I. Tools needed:

A. Goggles, welding

B. Gloves

C. Pliers

D. Oxyacetylene welding outfit

E. Wire brush

F. C Clamp

G. Welding table

H. Clear goggles

II. Materials needed:

A. Two pieces of 1/8" steel plate 2" wide by 6" long

B. 3/32" steel welding rod

C. Smith No. 5 welding tip

III. Procedure:

A. Clean metal for welding

B. Adjust oxygen and acetylene pressure to 5 lbs. each.

C. Place metal plates on table as shown in diagram A and tack weld on each end.

D. Light torch and adjust to neutral flame.

E. Hold torch in such a manner as to direct more heat to the lower plate than to the upper plate.

F. Begin weld by melting tack weld.

G. Move torch in a crescent motion and form a puddle large enough to cover edge of upper plate.

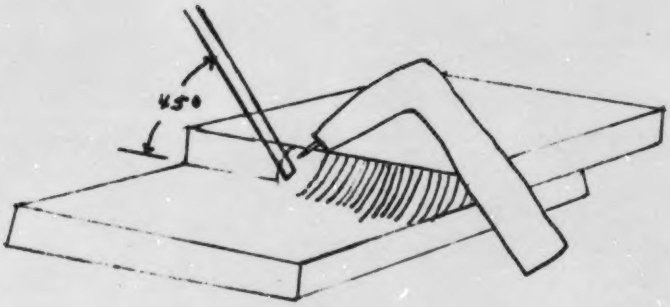
JOB SHEET #6

H. Weld the entire length of the joint.

I. To test weld, place in a vise and bend toward the face of the weld until it forms a "T" with the bottom plate. Examine the weld for complete penetration.

J. Continue to make this type of joint until good surface appearance and penetration is achieved.

K. Turn in to instructor for grade.



POSITION WELDING

JOB SHEET #7 - LAP WELD IN HEAVY PLATE

I. Tools needed:

  A. Goggles, welding

  B. Gloves

  C. Pliers

  D. Oxyacetylene welding outfit

  E. Wire brush

  F. C Clamp

  G. Welding table

  H. Clear goggles

II. Materials needed:

  A. Two pieces of ¼" steel plate 2" X 9"

  B. 1/8" steel welding rod

  C. No. 6 welding tip

III. Procedure:

  A. Clean metal for welding.

  B. Lap plates approximately ½" long direction.

  C. Clamp metal to table.

  D. Adjust pressure to 5 lbs. each for oxygen and acetylene.

  E. Light torch and adjust to neutral flame.

  F. Hold flame at approximately 80° angle directed in line of travel.

  G. Hold flame pointed slightly toward lower plate.

  H. Rotate flame clockwise in such a manner that the lower part of puddle is slightly ahead of upper part of puddle.

JOB SHEET #7

I. Add rod to produce bead which reaches top of upper plate.

J. Check bead for penetration when finished by bending toward face of weld.

K. Good weld should form "T" before breaking.

L. Continue running beads until satisfactory beads are obtained.

M. Turn in to instructor for grade.

POSITION WELDING

JOB SHEET #8 - BACKHAND WELDING ON HEAVY PLATE

I. Tools needed:

- A. Goggles, welding
- B. Gloves
- C. Pliers
- D. Oxyacetylene welding outfit
- E. Wire brush
- F. C Clamp
- G. Welding table
- H. Clear goggles

II. Materials needed:

- A. Two pieces of ¼" mild steel plate 3" X 9"
- B. 1/8" steel rod
- C. Smith No. 6 tip

III. Procedure:

- A. Prepare metal for welding.
- B. Align and tack plates as in diagram A.
- C. Adjust pressure to 5 lbs. each on oxygen and acetylene.
- D. Light torch and adjust to neutral flame.
- E. Establish puddle at the left end of joint and weld using back hand procedure as illustrated in diagram 2.
- F. Move flame in circular motion to produce smooth even bead.
- G. When bead is finished cool and observe underside of weld for penetration.

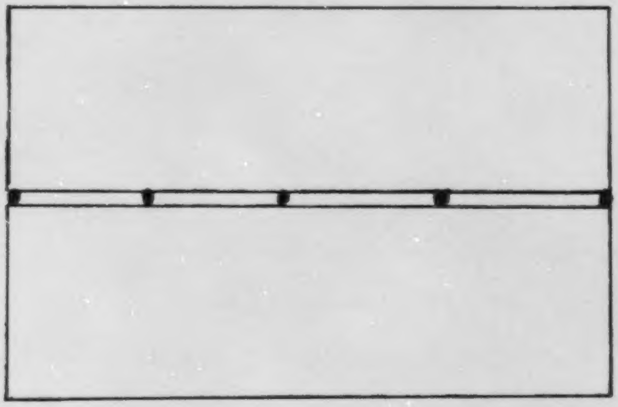
JOB SHEET #8

H. Test weld by bending toward face of weld. Weld should hold until bent to a 90° angle.

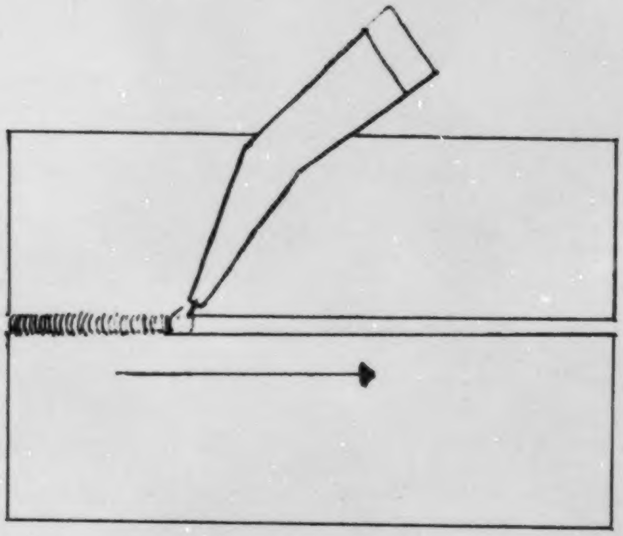
I. Continue making this type of weld until complete penetration is accomplished.

J. Turn in finished work for a grade.

DIAGRAM 1



DAIGRAM 2



POSITION WELDING

JOB SHEET #9 - BACKHAND WELDING OF LEVELED BUTT JOINT

I. Tools needed:

  A. Goggles, welding

  B. Gloves

  C. Pliers

  D. Oxyacetylene welding outfit

  E. Wire brush

  F. C Clamp

  G. Welding table

  H. Clear goggles

II. Materials needed:

  A. Two 3/8" steel plates 3" X 9"

  B. 3/16" diameter steel welding rod

  C. Smith No. 6 welding tip or equivalent

III. Procedure:

  A. Clean metal

  B. Bevel plates as shown in diagram 1.

  C. Leave 3/16" gap between plates.

  D. Adjust gas pressure to 5 lbs. for oxygen and acetylene.

  E. Light and adjust torch to a neutral flame.

  F. Tack weld plates at each end and in middle.

  G. This weld will require two passes to complete, using the following steps:

    1. Root bead is produced by backhand welding. (Welding away from flame)

JOB SHEET #9

    2. Heat is applied in sufficient amount to completely fuse metal.
    3. Torch is held at angle as shown in diagram 2.
    4. The welding rod may have to be removed for very short periods of time to allow heat to melt root of base metal.
    5. This root bead should fill lower, unleveled part of metal.

H. Top bead is produced as with other types of welds. (With flame directed in direction of travel.)

I. Flame should be moved in a circular motion and be pointed almost straight into metal.

J. Bead produces should not be more than 1/8" wider than top of bevel.

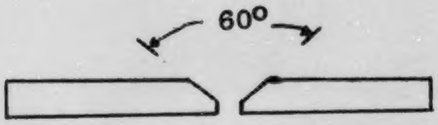
K. Bead should be slightly concave and smooth.

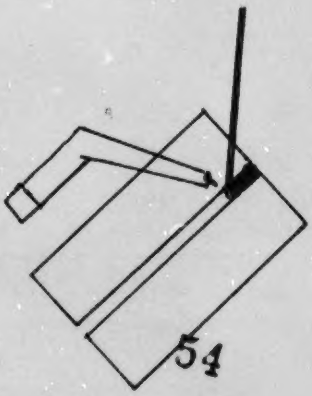
L. Test weld by bending toward face of weld.

M. Weld should bend to form an "L" without metal pulling loose.

N. Continue practice on this weld until good penetration and smooth appearance is produced.

O. Turn in to instructor for grade.





POSITION WELDING

JOB SHEET #10 - RUNNING BEADS WITH BRONZE ROD

I. Tools needed:

A. Goggles, welding

B. Gloves

C. Pliers

D. Oxyacetylene welding outfit

E. Wire brush

F. C Clamp

G. Welding table

H. Clear goggles

II. Materials needed:

A. 16 or 20 gauge steel plate 2" X 9"

B. 1/8" flux coated rods

C. Welding tip size 3

III. Procedure:

A. Thoroughly clean metal of all rust, oil or mill scale.

B. Adjust pressure on oxygen and acetylene to 5 lbs. each.

C. Adjust heat to a slightly oxidizing flame.

D. Beginning in the middle of one end of piece of metal, apply flame to both the metal and the welding rod at the same time until a drop of alloy is on the work.

E. Remove rod from flame and continue to heat the plate and droplet until it melts and flows over an area of approximately ½" in diameter.

F. Start a bead lengthwise on the plate, keeping the rod in close contact with the flame and rotating both flame and rod in a spiral motion.

JOB SHEET #10

G. Bring rod and flame in contact with metal on the down swing of the spiral.

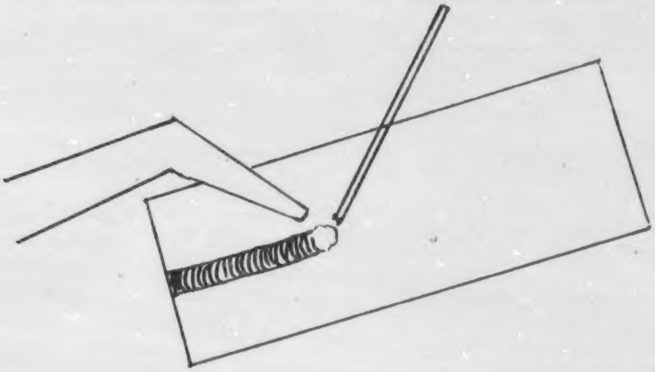
H. Drag rod in direction of brazing before removing it on the upswing.

I. Continue across metal in this manner until bead is finished.

J. After completion, inspect the finished bead for uniformity of width, height and ripples. (White residue indicates overheating.)

K. Make additional welds if needed to achieve uniform beads.

L. Turn work in to instructor for grade.



POSITION WELDING

JOB SHEET #11 - BRAZED BUTT JOINT ON LIGHT STEEL

I. Tools needed:

A. Goggles, welding

B. Gloves

C. Pliers

D. Oxyacetylene welding outfit

E. Wire brush

F. C Clamp

G. Welding table

H. Clear goggles

II. Materials needed:

A. Two pieces of 1/8" steel plate 2" X 9"

B. 1/8" flux coated rods

C. Tip one size larger than for welding comparable steel plate

III. Procedure:

A. Clean metal thoroughly.

B. Adjust pressure to 5 lbs. on oxygen and acetylene.

C. Light torch and adjust to slightly oxidizing flame.

D. Align and tack plates with edges of plates in contact with each other.

E. Begin at one end of joint with flame pointed in the direction of travel.

F. Preheat entire length of joint.

G. When metal has been preheated, move both to point of beginning and move flame and rod in spiral motion.

JOB SHEET #11

H. Bring rod and flame in contact with metal on the downswing.

I. Drag flux coated rod in direction of brazing before removing on upswing.

J. Continue across metal in this fashion until bead is finished.

K. Weld should be slightly above the surface of metal being welded, should have uniform ripples and be of a uniform width.

L. When satisfactory brazed joint is produced, turn in to instructor for grade.

POSITION WELDING

JOB SHEET #12 - BRAZED LAP JOINT

I. Tools needed:

- A. Goggles, welding
- B. Gloves
- C. Pliers
- D. Oxyacetylene welding outfit
- E. Wire brush
- F. C Clamp
- G. Welding table
- H. Clear goggles

II. Materials needed:

- A. Two pieces of 1/16" to 1/8" clean steel plate 2" X 9"
- B. 1/8" bronze rods
- C. Welding tip one size larger than for comparable plate

III. Procedure:

- A. Clean all rust and scale from metal.
- B. Overlap metal approximately one inch.
- C. Light and adjust flame to slightly oxidizing flame.
- D. Tack weld each end of lap.
- E. Direct flame slightly toward plate as alloy has tendency to flow on to top plate.
- F. Strive to control width of bead and to overcome tendency of bead to become excessively wide.
- G. Place finished bead in vise and bend toward face of weld.
- H. Check for bonding of bronze with the metal plate.

JOB SHEET #12

I. Continue making this type of weld until satisfactory beads are accomplished.

J. Turn in finished work to instructor for evaluation.

POSITION WELDING

JOB SHEET #13 - BRAZED FILLET JOINT

I. Tools needed:

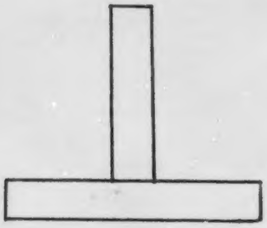
- A. Goggles, welding
- B. Gloves
- C. Pliers
- D. Oxyacetylene welding outfit
- E. Wire brush
- F. C Clamp
- G. Welding table
- H. Clear goggles

II. Materials needed:

- A. Two pieces 1/16" to 1/8" clean steel plate 2" X 9"
- B. 1/8" flux coated bronze rod
- C. Welding tip one size larger than for normal welding

III. Procedure:

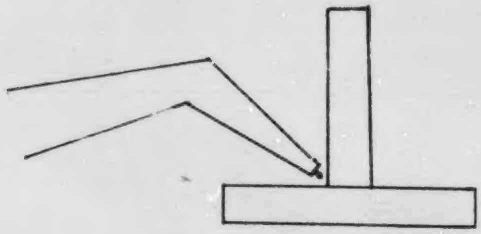
- A. Clean plates if necessary.
- B. Light and adjust flame to slightly oxidizing flame.
- C. Set up two plates as follows.



JOB SHEET #13

D. Tack weld with bronze rod.

E. Direct flame directly into joint as shown.



F. Avoid excessive tinning on upstanding leg.

G. Manipulate flame and rod in such a way as to produce even bonding on both plates.

H. Bend the finished bead and examine the root of the joint for uniformity of bond.

I. Continue to make this type of weld until satisfactory joint is produced.

J. Turn in to instructor for grade.

POSITION WELDING

JOB SHEET #14 - BRAZING HEAVY STEEL PLATE

I. Tools needed:

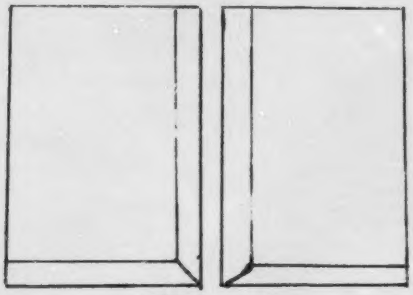
- A. Goggles,welding
- B. Gloves
- C. Pliers
- D. Oxyacetylene welding outfit
- E. Wire brush
- F. C Clamp
- G. Welding table
- H. Clear goggles

II. Materials needed:

- A. Two pieces ¼" steel plate 3" X 6"
- B. 1/8" flux coated bronze rod
- C. Welding tip one size larger than for welding similar plate

III. Procedure:

- A. Grind plates to a 45° angle.
- B. Align plates as in following diagram.



- C. Light torch and adjust to slightly oxidizing flame.

JOB SHEET #14

D. Tack plates at each end.

E. Braze joint making sure plate edges are tinned to the root of the joint.

F. Braze material should completely fill this "V" formed when plates are placed together.

G. Be careful not to overheat top edges of "V".

H. Bend toward face of weld to test for uniform bonding.

I. Make additional joints using more that one pass.

J. To do this, on first pass be sure the entire face of the "V" is tinned properly and the lower half of the "V" is filled with bronze leaving a slightly concave appearance.

K. On the second pass, the upper half of the "V" is filled and a slightly convex bead is produced.

L. Turn finished work in to instructor for grade.

POSITION WELDING

JOB SHEET #15 - BRAZING CAST IRON

I. Tools needed:

  A. Goggles, welding

  B. Gloves

  C. Pliers

  D. Oxyacetylene welding outfit

  E. Wire brush

  F. C Clamp

  G. Welding table

  H. Clear goggles

II. Materials needed:

  A. Scrap pieces of cast iron ¼ to ½" thick

  B. 1/8" bronze cast iron flux

  C. Smith tip B64

III. Procedure:

  A. Grind one edge of each piece of metal at a 45° angle leaving 1/16" of unground surface at bottom of bevel.

  B. Place the metal on welding table with the beveled side up, forming a "V".

  C. Leave 1/16" between the two pieces.

  D. Adjust pressure to 5 lbs. each for oxygen and acetylene.

  E. Light torch and adjust to a neutral flame.

  F. Warm metal entire length of joint.

  G. Heat both pieces of metal to a dull cherry red color.

JOB SHEET #15

H. Melt a small amount of flux coated rod and tin about one inch along each side of "V".

I. Use s semicircular motion to spread the melted bronze in a thin coat.

J. Fill up the section of "V" that has been tinned to the proper width and height.

K. Continue welding along joint by heating to a dull cherry red color and tinning a length of one inch section and then filling this section to proper height.

L. Do not try to apply bronze until the dull cherry red color of metal is obtained as this will lead to the overheating of the bronze.

M. Inspect the finished piece to see that the weld has penetrated to the bottom of the joint and that it has a uniformed rippled bead. The bead should be about 1/16" above the surface of the metal and no wider that the "V".

N. Continue making this type of weld until it meets the criteria as set forth in step 13.

O. Turn in to instructor for grade.

POSITION WELDING

TEST

I. Define the following six terms associated with oxyacetylene welding.

A. Fusion -

B. Tack Weld -

C. Penetration -

D. Base Metal -

E. Excess Oxygen Flame -

F. Inner Cone -

II. Name five factors that determine weld quality.

A.

B.

C.

D.

E.

III. List three factors that determine tip selection.

A.

B.

C.

IV. List two factors that determine rod selection.

A.

B.

V. Name three types of flames.

A.

B.

C.

POSITION WELDING

ANSWERS TO TEST

I. A. Intimate mixing of molten metals.

B. Small weld used to temporarily hold together components of an assembly.

C. Extent the fusion goes into the base metal as measured from the surface of the base metal.

D. Metal to be welded, cut or brazed.

E. When extra oxygen is turned on after a neutral flame has been produced.

F. The cone shaped, white inner flame of a neutral or near neutral flame.

II. A. Proper flame adjustment

B. Angle of tip

C. Distance from work

D. Speed of travel

E. Movement of tip

III. A. Metal thickness

B. Size of welding rod

C. Type of weld desired

IV. A. Type of metal to be welded

B. Thickness of metal

V. A. Neutral flame

B. Carburezing flame

C. Oxidizing flame

USE OF CUTTING TORCH

UNIT III

SECTION A

USE OF CUTTING TORCH

TERMINAL OBJECTIVE

After completion of this unit, the student should be able to light, adjust and turn off an oxyacetylene cutting unit following proper order and safety precautions.The student should be able to cut straight lines, cut circles, bevel cut and pierce holes. This knowledge will be evidenced by scoring at least eighty-five percent on the unit test and by demonstrating skill on completion of job sheets.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

I. Match terms associated with oxyacetylene cutting.

II. Identify parts of the torch body and cutting attachment.

III. List six items of importance in regard to cutting.

IV. List four causes of backfire.

V. List the two types of flashback.

VI. List in the proper order the steps to follow in case of a flashback.

VII. Demonstrate the ability to:

   A. Set up an oxyacetylene cutting torch

   B. Light a cutting torch

   C. Cut straight lines in thin metal

   D. Cut straight lines on thick plate

   E. Make beveled cut in thick plate

USE OF CUTTING TORCH

SUGGESTED ACTIVITIES

I. Instructor:

   A. Provide students with objective sheets.

   B. Provide students with information and job sheets.

   C. Make transparencies.

   D. Discuss terminal and specific objectives.

   E. Discuss information sheets

   F. Demonstrate and discuss procedures outlined in job sheets.

   G. Give test.

II. Students:

   A. Read objectives

   B. Study information sheets

   C. Demonstrate the ability to accomplish procedures outlined in job sheets.

   D. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

   A. Objectives

   B. Information sheets

   C. Transparency masters

      1. TM 1 - Parts of Torch Body and Cutting Attachment

   D. Job sheets

      1. Job sheet #1 - Setting Up an Oxyacetylene Cutting Torch

2. Job sheet #2 - Lighting and Adjusting A Cutting Torch

3. Job sheet #3 - Cutting Straight Lines on Thin Plate

4. Job sheet #4 - Cutting Straight Lines on Thick Plate

5. Job sheet #5 - Making Beveled Cuts In Thick Plate

E. Test

F. Answers to test

II. References:

A. Althouse, Andrew D., Turnquist, Carl H. and Bowditch, William A., Modern Welding, Homewood, Illinois, The Goodheart Wilcox Co.

B. Parker, Marvin M., Farm Welding, New York, New York, McGraw Hill Book Co.

C. Oklahoma Core Curriculum Material, Welding, Stillwater, Oklahoma.

USE OF CUTTING TORCH

INFORMATION SHEET

I. Terms and definitions:

A. PREHEAT FLAME - Small flames around cutting tip used to heat metal before cut is made.

B. CUTTING TORCH - Used only for cutting, attaches directly to hose.

C. CUTTING ATTACHMENT - Connects to torch body to change it from a welding torch to a cutting torch

D. SLAG - Hot oxidized metal blown from cut.

E. OXYGEN CUTTING JET - Hole in center of slip in tip.

F. KERF - Cut produced by oxyacetylene torch.

G. DRAG - The laging behind of the cutting stream on thick metal.

H. SLAG STREAM - Hot molten metal removed in cutting operation.

I. OXIDATION - Combining of oxygen with any other substance.

J. FLASHBACK - A burning of the gas inside the torch and hose.

K. BACKFIRE - A short "pop" of the torch flame followed by extinguishing of the flame or the continued lowering of the gases.

L. CUTTING FLAME - Cutting by a rapid oxidation process at a high temperature produced by a gas flame accompanied by a jet action which blows the oxide away from the cut.

II. Parts of cutting torch and cutting tip.

A. Cutting torch:

1. Oxygen fitting
2. Acetylene fitting
3. Oxygen torch valve

INFORMATION SHEET

4. Acetylene torch valve
5. Torch body
6. Oxygen cutting lever
7. Oxygen preheat valve
8. Tip nut
9. Slip-in tip

B. Cutting tip

1. Preheat orifice heats metal to kindling point of approximately 1600° F.
2. Cutting orifice removes oxidized metal.

III. Six items of importance in regard to cutting.

A. Pressure of oxygen fed to the cut

B. Size of oxygen jet orifice

C. Speed of the cutting torch across the metal

D. Distance of the preheat flame from the metal

E. Size (amount of heat) of the preheat flame

F. Angle of cutting tip relative to the metal

IV. Four causes of backfire.

A. The gas if flowing out too slowly and the pressure is too low for size tip being used.

B. Overheating of tip caused by over use or operation in hot corner, or too close to metal.

C. Inside of tip may have carbon deposits or hot metal lodged inside the orifice of the tip.

D. Bad o-rings in torch body.

V. Two types of flashback.

A. Back in to the acetylene hose-When oxygen feeds back into the acetylene hose, a combustible mixture forms and a violent explosion occurs.

INFORMATION SHEET

B. In the oxygen hose - Organic oxides form inside the hose. If the hose is raised to the ignition point, an explosion may result.

VI. Steps to follow in case of a flashback.

A. Close oxygen preheat valve

B. Close oxygen torch valve

C. Close acetylene torch valve

D. Release oxygen regulator screw

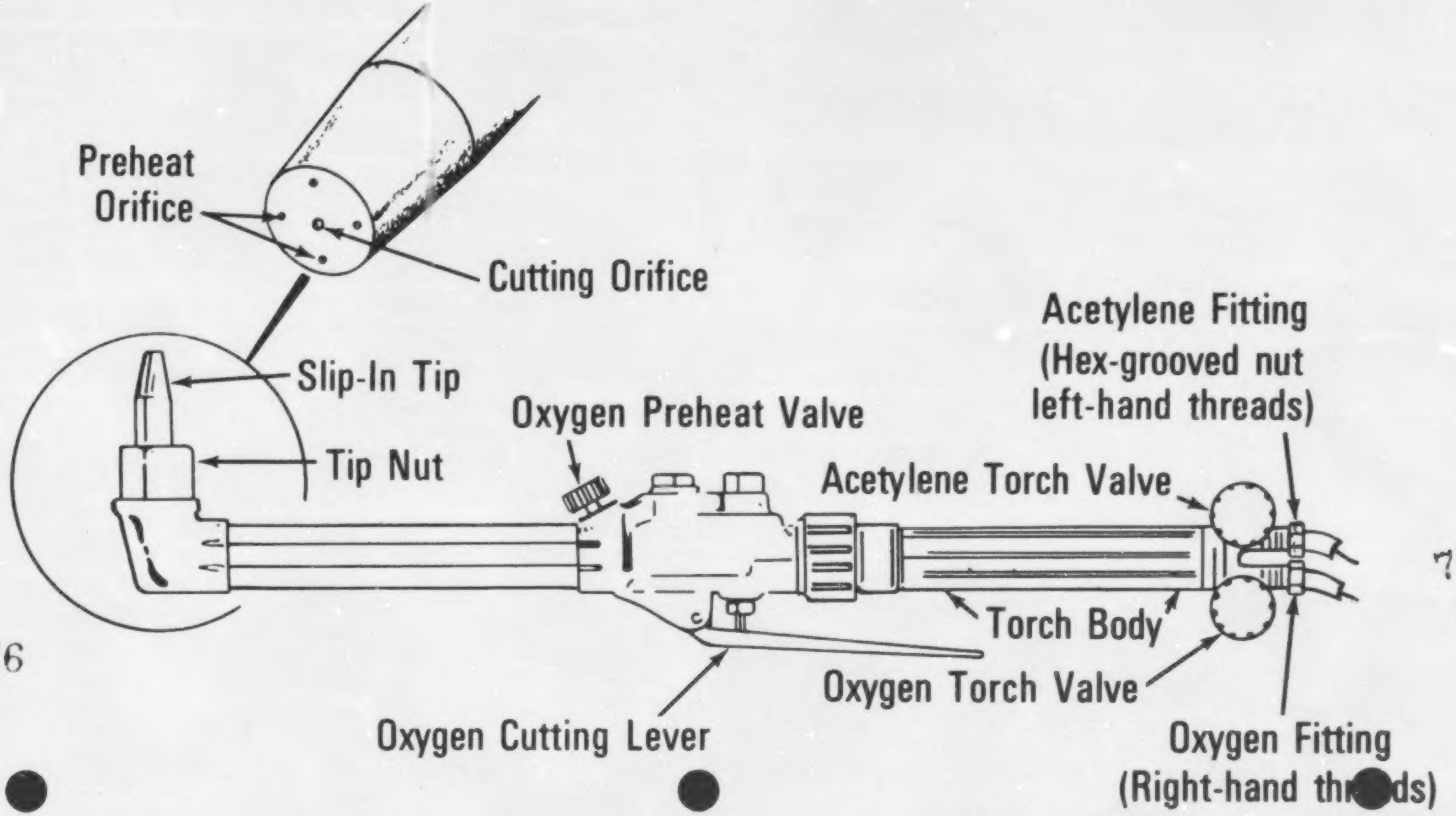
E. Release acetylene regulator screw

F. Examine acetylene unit

G. Reset regulator pressure

H. Light torch

Parts of a Torch Body and Cutting Attachment


Preheat Orifice
Cutting Orifice
Slip-In Tip
Tip Nut
Oxygen Preheat Valve
Acetylene Fitting (Hex-grooved nut left-hand threads)
Acetylene Torch Valve
Torch Body
Oxygen Torch Valve
Oxygen Cutting Lever
Oxygen Fitting (Right-hand threads)

USE OF CUTTING TORCH

JOB SHEET #1 - SETTING UP AN OXYACETYLENE CUTTING TORCH

I. Tools and materials needed:

   A. Oxygen cylinder

   B. Acetylene cylinder

   C. Oxygen regulator

   D. Acetylene regulator

   E. Hoses

   F. Wrench

   G. Cylinder holder

   H. Water container

   I. Ivory soap

   J. Clean paint brush

   K. Torch body with tips

II. Procedure:

   A. Fasten cylinders in a vertical position

   B. Remove caps from cylinders

   C. Crack valves of each cylinder, then close valves

   D. Connect oxygen regulator to oxygen cylinder

      1. Turn adjusting screw on regulator counterclockwise until tension on spring is released.

      2. Slowly turn cylinder valve wide open

   E. Connect acetylene regulator to acetylene cylinder

      1. Turn adjusting screw on regulator counterclockwise until tension on spring is released

      2. Open cylinder valve 1/2 to 3/4 of a turn (never more than 1/2 turns)

JOB SHEET #1

F. Connect acetylene hose to acetylene regulator and purge.

G. Connect oxygen hose to oxygen regulator and purge hose.

H. Connect torch body to oxygen and acetylene hose and close both valves on torch body.

I. Attach cutting attachment to torch body.

NOTE: The size tip is determined by the thickness of metal to be cut and the manufacturers recommendations.

J. Close oxygen preheat valve on cutting attachment.

K. Turn adjusting screw on oxygen regulator clockwise until working pressure is reached.

L. Turn adjusting screw on acetylene regulator clockwise until correct working pressure is reached.

M. Test all connections for leaks with Ivory soap suds and water.

USE OF CUTTING TORCH

JOB SHEET #2 - LIGHTING AND ADJUSTING A CUTTING TORCH

I. Tools and materials needed:

A. Oxygen cylinder

B. Acetylene cylinder

C. Hoses

D. Oxygen and acetylene regulators

E. Torch body

F. Cutting attachment with slip-in tip

G. Cylinder holder and hose rack

H. Flint lighter

I. Wrench

J. Gloves

K. Safety goggles

L. Coveralls or protective clothing

II. Procedure:

A. Check all cylinders, regulators and torch valves to make sure they are off.

B. Open acetylene cylinder valve 1/2 to 3/4 of a turn (never more than 1½ turns).

C. Open acetylene valve on torch one turn.

D. Turn adjusting screw on acetylene regulator clockwise until desired pressure is reached.*

E. Close acetylene valve on torch

*Oxygen and acetylene pressures and size of tip depend upon thickness of metal to be cut. Use pressures and tip size recommended by manufacturer.

JOB SHEET #2

F. Open oxygen cylinder valve all the way.

G. Open oxygen torch valve all the way.

H. Open oxygen preheat valve on cutting attachment one turn.

I. Turn adjusting screw on oxygen regulator clockwise until desired pressure is reached.

J. Close oxygen preheat valve on cutting attachment.

K. Open acetylene valve on torch 1/4 turn.

L. Light the torch with flint lighter and adjust until smoke on flame clears.

M. Open oxygen preheat valve slowly and adjust to a neutral flame.

NOTE: If necessary, adjust the oxygen preheat valve with the oxygen cutting lever depressed until a neutral flame is secured.

III. Procedure for turning off the flame and oxyacetylene unit:

A. Close acetylene valve on torch.

B. Close oxygen preheat valve.

C. Close acetylene cylinder valve.

D. Close oxygen cylinder valve.

E. Open acetylene valve on torch.

NOTE: When gauges reach 0, close torch valve and release adjusting screw on acetylene regulator by turning counterclockwise.

F. Open oxygen preheat valve on torch.

NOTE: When gauges reach 0, close oxygen preheat valve and release adjusting screw on oxygen regulator by turning counterclockwise.

G. Close oxygen valve on torch.

H. Place torch and hose on hanger or brackets provided.

USE OF CUTTING TORCH

JOB SHEET #3 - CUTTING STRAIGHT LINES ON THIN PLATE

I. Tools needed:

A. Complete cutting outfit with tip assembly

B. Soapstone

C. Square

D. Safety goggles

E. Pliers

F. Gloves

G. Coveralls

H. Flint lighter

I. Cutting tip

J. C Clamp

K. Metal box or bucket to catch slag

II. Material needed:

A. 1-1/8 inch plate 6" X 8"

III. Procedure:

A. With square and soapstone, mark off parallel lines 1" apart across plate.

B. Adjust oxygen regulator.

C. Adjust acetylene regulator.

D. Clamp thin metal to be cut on edge of table with portion to be cut extending over edge of table.

E. Light torch.

F. Adjust to neutral flame.

G. Assume comfortable position.

JOB SHEET #3

H. Grasp the torch in right hand with thumb on the cutting line.

I. Use left hand to support the end of the torch.

J. Use the little finger side of left hand to slide along metal to maintain proper height of torch head and to give a smooth cut.

K. Heat the right edge of the piece of metal at the line with the preheat flame.

L. Hold torch at a 15° to 20° angle with flame directed in direction of travel.

M. As metal begins to melt, press the oxygen cutting lever and proceed along length of cut.

N. Stand in such a way as to observe kerf as weld proceeds.

O. If kerf fails to penetrate through metal, stop, move to one side of cut, preheat and begin cut again. Move into kerf and cut through uncut portion.

P. Continue cutting strips until metal is cut successfully.

Q. Varying speed will help determine proper speed for cutting.

R. Turn strips in to instructor for grade.

USE OF CUTTING TORCH

JOB SHEET #4 - CUTTING STRAIGHT LINES IN THICK PLATE

I. Tools needed:

- A. Complete cutting outfit with tip assembly
- B. Soapstone
- C. Square
- D. Safety goggles
- E. Gloves
- F. Pliers
- G. Coveralls
- H. Flint lighter
- I. Cutting tip
- J. C Clamp
- K. Metal box or bucket to catch slag

II. Material needed:

- A. 1-½ to ½ inch plate 6" X 8"

III. Procedure:

- A. With square and soapstone, mark off parallel lines 1 inch apart across metal.
- B. Adjust oxygen regulator
- C. Adjust acetylene regulator
- D. Clamp metal to be cut on edge of table with portion to be cut extending over edge of table.
- E. Light torch
- F. Adjust to neutral flame
- G. Assume comfortable position where you can observe kerf as cut proceeds.

JOB SHEET #4

H. Grasp the torch with right hand with thumb on the cutting lever.

I. Use left hand to support the end of the torch.

J. Use little finger side of left hand to slide along metal to maintain proper height of torch head and to give a smooth cut.

K. Hold torch at a 90° angle to metal to be cut.

L. Heat edge of metal with flame held about 1/8" above metal.

M. When the edge of the metal begins to melt, press the oxygen cutting valve slowly until it is wide open.

N. After cut is started, maintain a 90° angle to work and proceed across metal.

O. If kerf fails to penetrate through metal, stop, move to one side of cut, preheat and begin cut again. Move back into kerf and cut through uncut portion.

P. Continue cutting strips until metal is cut successfully.

Q. Turn strips in to instructor for grading.

USE OF CUTTING TORCH

JOB SHEET #5 - MAKING BEVEL CUTS IN THICK PLATE

I. Tools needed:

  A. Complete cutting outfit with tip assembly

  B. Soapstone

  C. Square

  D. Safety goggles

  E. Gloves

  F. Pliers

  G. Coveralls

  H. Flint lighter

  I. Cutting tip

  J. C Clamp

  K. Metal box or bucket to catch slag

II. Material needed:

  A. 1-½" plate 6" X 8"

III. Procedure:

  A. With square and soapstone, mark off lines 2" apart.

  B. Adjust oxygen regulator

  C. Adjust acetylene regulator

  D. Clamp metal to edge of table

  E. Light torch

  F Adjust to neutral flame

  G. Assume comfortable position

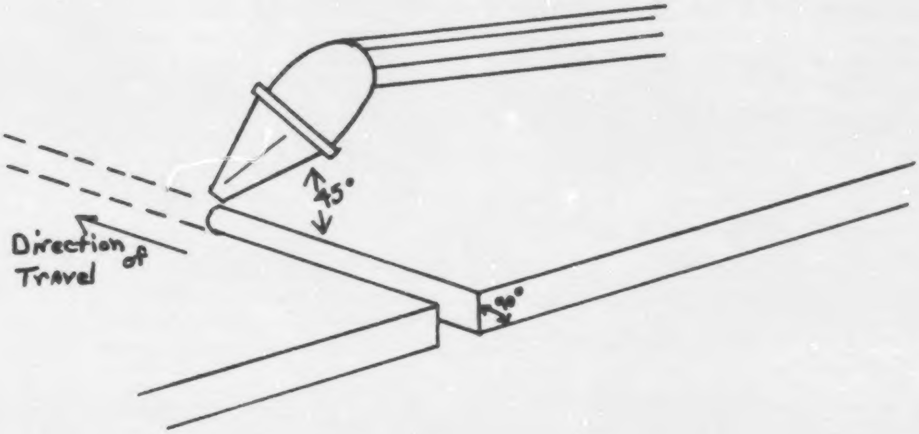
  H. Grasp torch with right hand with thumb on the cutting line.

JOB SHEET #5

I. Use left hand to support the end of torch.

J. Use little finger side of hand to slide along metal to maintain proper height of torch head and to give a smooth cut.

K. Hold torch at 45° angle to metal and 90° angle to the direction of travel.



L. Heat metal at edge until it begins to melt holding flame 1/8" above metal.

M. Press oxygen lever slowly until fully open.

N. Proceed slowly across metal being careful to maintain 45° angle cut.

O. Check cut pieces of metal with combination square to determine if 45° angle has been achieved.

P. Continue making bevel cuts until satsifactory cut is accomplished.

Q. Turn in to instructor for grade.

USE OF CUTTING TORCH

TEST

I. Match the terms listed below to the correct definition.

___A. Hot oxidized metal blown from cut.

___B. Small flames around cutting tip used to heat metal before cut is made.

___C. Hole in center of slip-in tip.

___D. The laging behind of the cutting stream on thick metal.

___E. Combining of oxygen with any material.

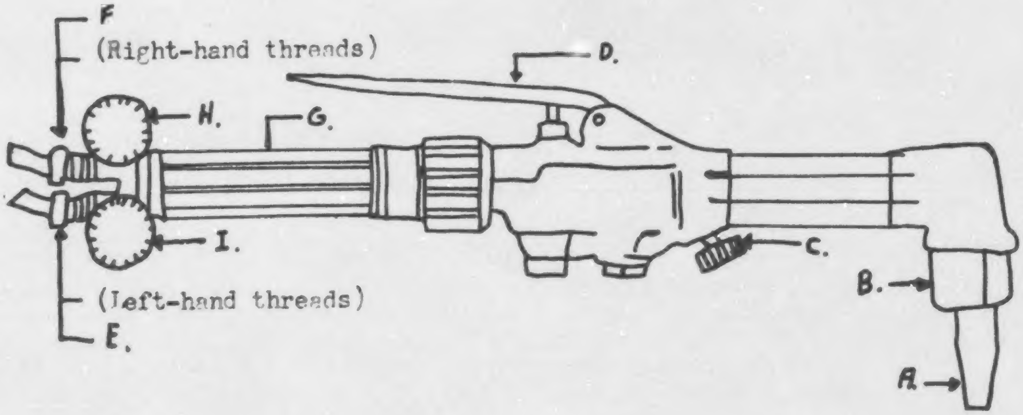
___F. A short "pop" of the torch flame followed by extinguishing of the flame or the continued lowering of the gases.

___G. Cut produced by oxyacetylene torch.

___H. A burning of gas inside torch and hose.

1. Kerf
2. Flashback
3. Drag
4. Preheat Flame
5. Backfire
6. Oxygen Cutting Jet
7. Slag
8. Oxidation

II. Identify parts of the torch body and cutting attachment.



A.

B.

C.

D.

E.

F.

G.

H.

I.

III. List six items of importance in regard to cutting.

A.

B.

C.

D.

E.

F.

IV. List four causes of backfire.

A.

B.

C.

D.

V. List two types of flashback.

A.

B.

VI. List in order the steps to follow in case of a flashback.

A.

B.

C.

D.

E.

F.

G.

H.

USE OF CUTTING TORCH

ANSWERS TO TEST

I. A. 7
B. 4
C. 6
D. 3
E. 8
F. 5
G. 1
H. 2

II. A. Slip-in tip
B. Tip nut
C. Oxygen preheat valve
D. Oxygen cutting lever
E. Acetylene fitting
F. Oxygen fitting
G. Torch body
H. Oxygen torch valve
I. Acetylene torch valve

III. A. Pressure of oxygen fed to the cut
B. Size of oxygen jet orifice
C. Speed of the cutting torch across the metal
D. Distance of the preheat flame from the metal
E. Size of the preheat flame
F. Angle of cutting tip relative to the metal

IV. A. The gas is flowing too slowly and the pressure is too low for size tip being used.

B. Overheating of tip caused by over use or operation in hot corner or too close to metal.

C. Inside of tip may have carbon deposits or hot metal lodged inside the orifice of the tip.

D. Bad o-rings in torch body.

V. A. Back into the acetylene hose - When oxygen feeds back into the acetylene hose, a combustible mixture forms and a violent explosion occurs.

B. In the oxygen hose - Organic oxides form inside the hose. If the hose is raised to the ignition point, an explosion may result.

VI. A. Close oxygen preheat valve

B. Close oxygen torch valve

C. Close acetylene torch valve

D. Release oxygen regulator screw

E. Release acetylene regulator screw

F. Examine acetylene unit

G. Reset regulator screw

H. Light torch

ARC WELDING

UNIT I

SECTION B

ARC WELDING

TERMINAL OBJECTIVE

After completion of this unit, the student should have a basic knowledge of the principles of arc welding. This knowledge will be evidenced through demonstration and by scoring at least eighty percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

I. Match terms associated with arc welding to the correct definition.

II. List ten safety precautions associated with arc welding.

III. Name and describe three types of arc welders.

IV. Name three types of electrodes by use.

V. List four classes of electrodes.

VI. Name the two most common sizes of electrodes.

VII. Describe the method of electrode classification.

VIII. Explain the two ways of establishing an arc.

IX. List two ways of determining correct arc length.

X. Name the three types of welds.

XI. List the four welding positions.

XII. Name four types of welded joints.

XIII. List three reasons for poor welds.

ARC WELDING

SUGGESTED ACTIVITIES

I. Instructor:

  A. Provide students with objectives

  B. Provide students with information sheets

  C. Make transparencies

  D. Discuss terminal and specific objectives

  E. Discuss information sheets

  F. Demonstrate and discuss procedures outlined in this unit.

  G. Give test

II. Students:

  A. Read objectives

  B. Study information sheets and take notes.

  C. Demonstrate the ability to accomplish the procedures set forth in this unit.

  D. Take test

INSTRUCTIONAL MATERIALS

I. Included in this unit:

  A. Objective sheets

  B. Information sheets

  C. Transparency masters

    1. TM 1 - AWS Classification of Electrodes

    2. TM 2 - Kinds of Welds

    3. TM 3 - Types of Welded Joints

    4. TM 4 - Welding Positions

D. Test

E. Answers to test

II. References:

A. Althouse, Turnquist and Bowditch, Modern Welding, Homewood, Illinois, The Goodheart Wilcox Co. Inc.

B. Griffin, Roden, Welding Processes, Albany, New York, Delmar Publishers.

C. Jones, N.N., Shopwork On The Farm, New York, New York, McGraw Hill Book Co., 1955.

ARC WELDING

INFORMATION SHEET

I. Terms and definitions:

A. ARC WELDING - Term used to describe process of joining two pieces of metal together by the heat produced by an electric arc.

B. AC - Alternating current.

C. DC - That kind of electric current which flows in one direction.

D. SLAG - Non-metallic substance covering a welded joint.

E. BASE METAL - Metal to be welded.

F. ELECTRODE - Metal rod which conducts a current from the electrode holder to the base.

G. ARC LENGTH - That distance from the tip of the electrode to the bottom of the crater during the welding process.

H. HELMET - A protecting hood which fits over the arc welders head providing a lens of safety glass through which the operator may safely observe the electric arc.

I. BEVEL - Type of edge penetration.

J. CRATER - Depression at the end of weld.

II. Safety precautions in arc welding.

A. Never look at the welding arc with the naked eye.

B. Always use a head or face shield that is in good condition.

C. Wear suitable clothing to protect all parts of the body from arc burn and from spatter, such as leather gloves, long sleeved shirts with cuffs and collars buttoned and cuffs on pants turned down.

D. Do not strike an arc weld until you are sure those in the vicinity have protective equipment or will look in the other direction.

INFORMATION SHEET

E. Do not weld around combustible or flammable material.

F. Do not pick up hot metal.

G. Do not weld in confined places without adequate ventilation.

H. Always open the main switch or disconnect the plug when checking over the welder.

I. Do not leave the electrode holder on the welding table or in contact with a grounded metal surface.

J. Do not use worn or frayed cables.

K. Stand on dry footing when welding and keep the body insulated from the electrode, the electrode holder and the work.

L. Keep the shop clean, particularly around the welder.

III. Types of arc welders.

A. AC (alternating current) - Current through the arc continually alternates or reverses itself 120 times per second on 60 cycle current.

B. DC (direct current) - Current flows in one direction.

C. TIG - May use AC or DC with a non-consumable tungsten electrode and an inert shielding gas.

D. MIG - May use AC or DC with a base wire filler material that is fed automatically into weld; also has an inert shielding gas.

IV. Types of electrodes.

A. Mild steel - E6011, E6012, E6013

B. Cast Iron - Nickel alloy, steel rod

C. High carbon steel - E6016

D. Hard surfacing - Alloy steel electrodes, no AWS number available

INFORMATION SHEET

V. Classes of electrodes.

A. Bare electrode

B. Dusted

C. Flux coated electrode

D. Extruded electrodes and coverings (Flux dipped and extruded electrodes most popular)

VI. Two most common sizes of electrodes.

A. 1/8"

B. 5/32"

NOTE: Electrodes vary in size from 1/16" to 3/8". The size is determined by the diameter of the bare end of the electrode. Large electrodes can carry larger currents and produce more heat and are used for welding thick materials.

VII. Method of electrode classification.

A. AWS - American welding society

B. E - Designates that electrode is of the metal arc type.

C. 60 - The first two digits refer to the tensil strength of the deposited weld metal in thousands of pounds per square inch.

D. 1 - The third digit to the position in which the electrode can be used.

E. 3 - The fourth digit shows some special characteristic of the electrode; weld quality, type of arc and amount of penetration.

VIII. Methods of establishing an arc.

A. Scratching - Moving the end of electrode down onto the work with a slow sweeping motion similar to striking a match. When the electrode touches the metal, continue the sweeping motion a little further, raising the electrode slightly.

INFORMATION SHEET

B. Tapping - Keep electrode perpendicular to the work, lowering it slowly and tapping or bouncing it lightly on the work.

IX. Determining correct arc length.

A. Correct arc length is determined by size of electrode. Length of arc should be equal to diameter of bare end of the electrode.

B. Correct arc length can be determined by sound. Correct arc length, with proper machine adjustment, gives a sharp crackling or frying sound.

X. Three types of welds.

A. Bead - A deposit of weld metal made on the surface by the single pass of the electrode.

B. Groove - Consists of one or more beads deposited in a groove. (Used for connecting pieces of metal together.)

C. Fillet - Consists of one or more beads deposited in the angle or corner between two surfaces, as in a tree, lap or corner joint.

XI. The four welding positions.

A. Flat position - Welding on top of a surface that is level or nearly so.

B. Horizontal - Making a horizontal weld on a vertical surface.

C. Vertical - Running a bead vertically up or down on a vertical surface.

D. Overhead - Welding on the underside of a horizontal surface.

XII. Types of welded joints. TM 3

A. Plain butt joint

B. Grooved butt joint

C. Lap joint

D. Corner joint

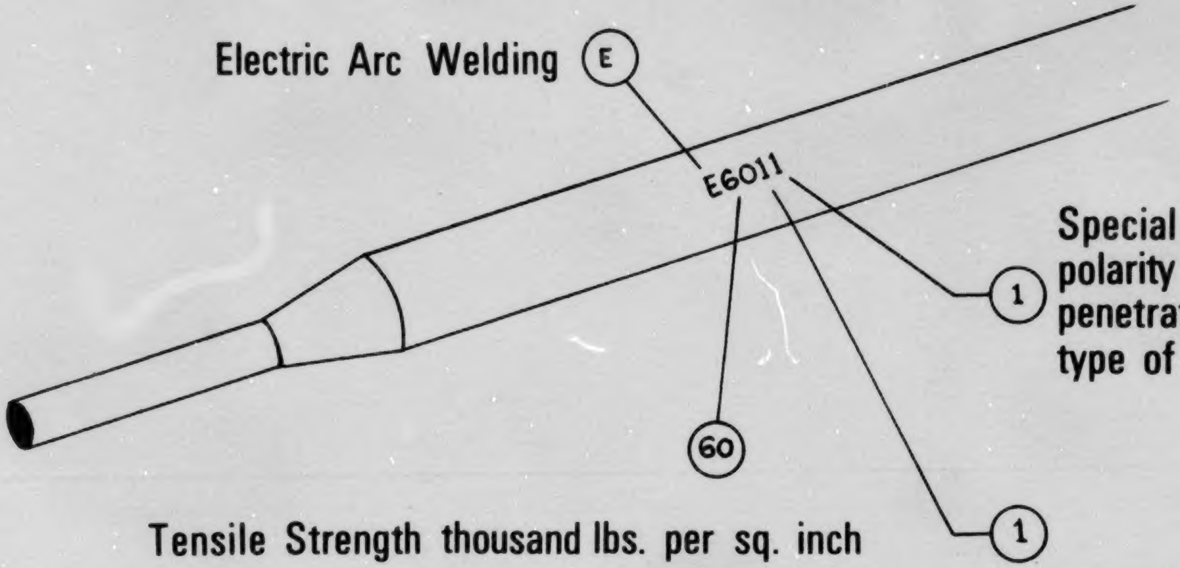
INFORMATION SHEET

- E. Tee joint
- F. Edge joint

XIII. Reasons for poor welds.

- A. Improper adjustment of machine
- B. Dirty metal
- C. Wrong size electrode
- D. Improper arc length
- E. Holding electrode at wrong angle
- F. Wrong type of electrode

AWS Classification of Electrodes



Electric Arc Welding

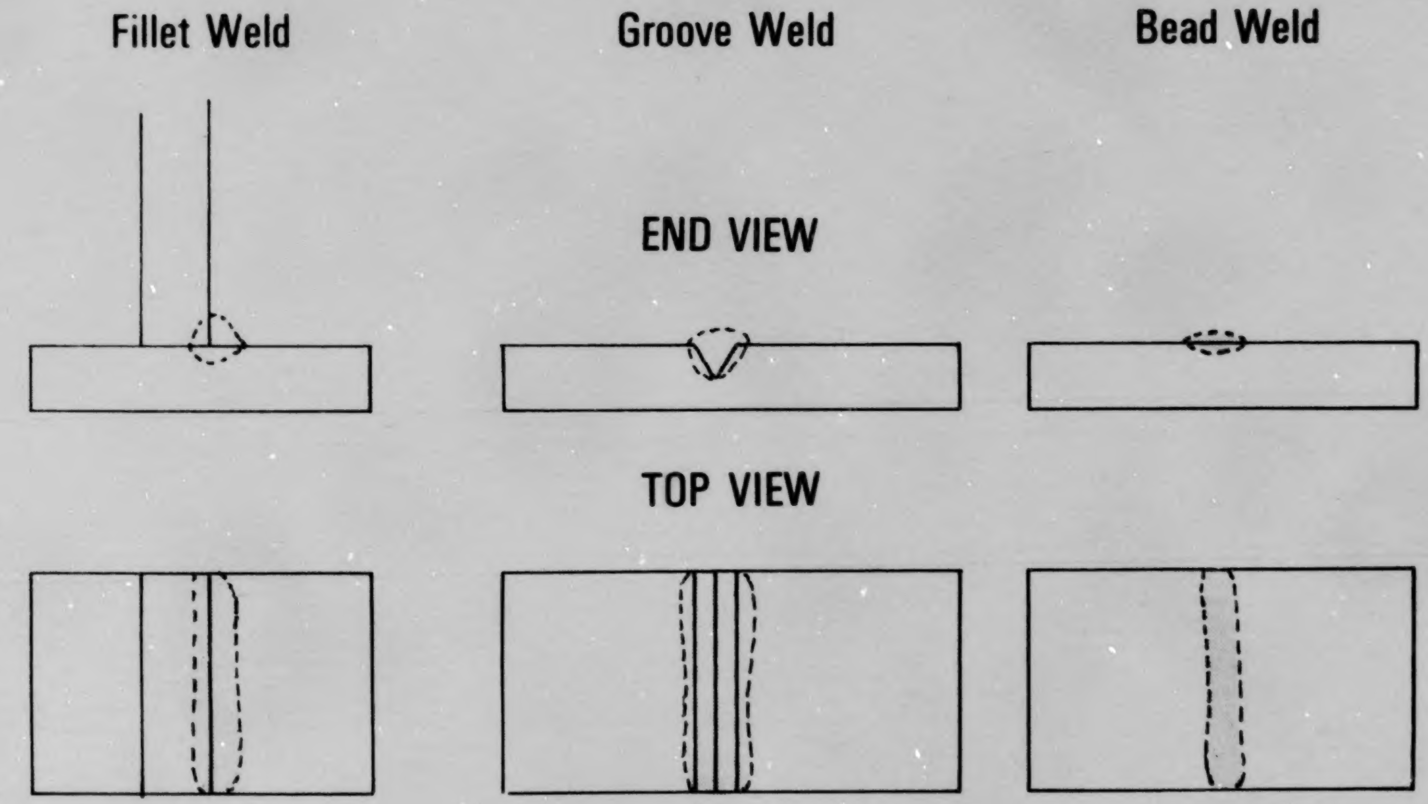
Special char.
polarity
penetration
type of welder

Tensile Strength thousand lbs. per sq. inch

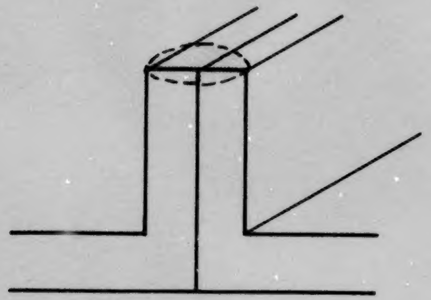
Welding Position
1. all positions
2. flat and horizontal
3. flat

E6011 MILD STEEL ELECTRODE

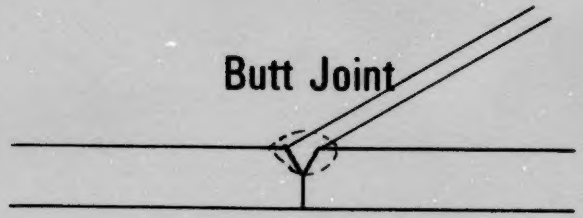
Kinds of Welds


Fillet Weld
Groove Weld
Bead Weld
END VIEW
TOP VIEW

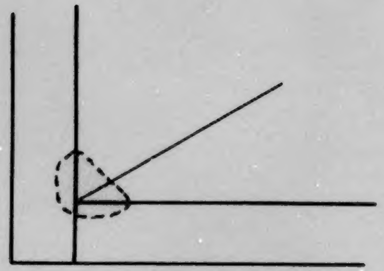
Types of Weld Joints



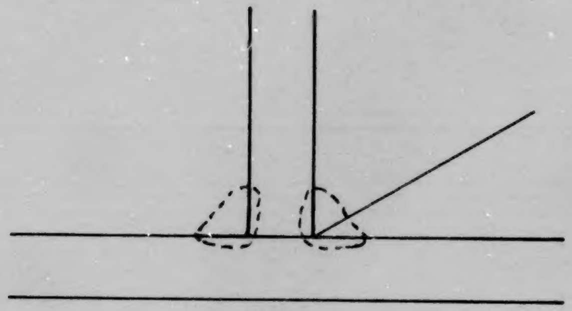
Edge Joint



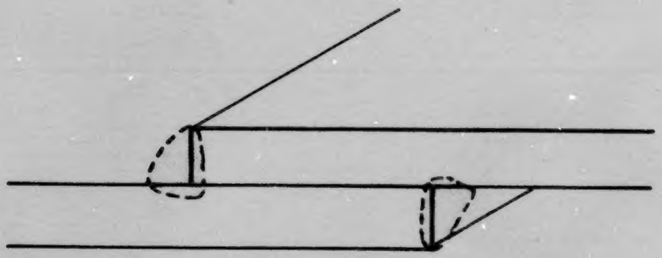
Butt Joint



Corner Joint

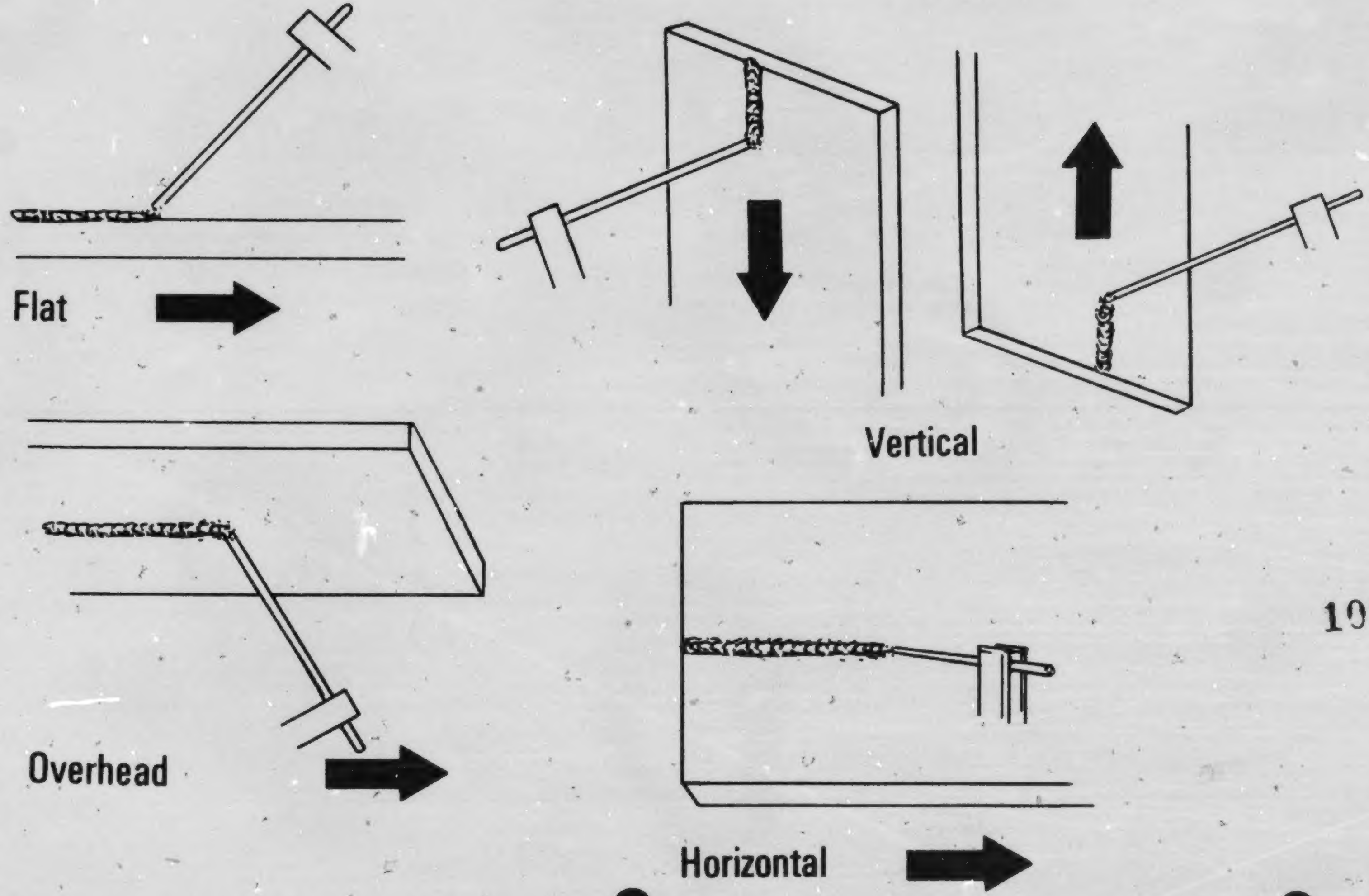


T Joint



Lap Joint

Welding Positions


Flat
Vertical
Overhead
Horizontal

ARC WELDING

TEST

I. Match the terms listed below to the correct definition.

___A. Metal rod which conducts a current from the electrode holder to the base metal.

___B. Non-metallic substances covering a welded joint.

___C. That distance from the tip of the electrode to the bottom of the crater during the welding process.

___D. Term used to describe process of joining two pieces of metal together by the heat produced by an electric arc.

___E. Type of edge penetration.

___F. Alternating current

___G. Metal to be welded.

___H. That kind of electric current which flows in one direction.

1. Electrode
2. Arc Welding
3. Bevel
4. AC
5. Arc Length
6. Base Metal
7. DC
8. Slag

II. List ten safety precautions associated with arc welding.

A.

B.

C.

D.

E.

F.

G.

H.

I.

J.

III. Name and describe three types of arc welders.

A.

B.

C.

IV. Name three types of electrodes by use.

A.

B.

C.

V. List four classes of electrodes.

A.

B.

C.

D.

VI. Name the two most common sizes of electrodes.

A.

B.

VII. Describe the following methods of electrode classification.

A. AWS-

B. E-

C. The first two digits-

D. The third digit-

E. The last digit-

VIII. Explain the two ways of establishing an arc.

A.

B.

IX. List two ways of determining correct arc length.

A.

B.

X. Name the three types of welds.

A.

B.

C.

XI. List the four welding positions.

A.

B.

C.

D.

XII. Name four types of welded joints.

A.

B.

C.

D.

XIII. List three reasons for poor welds.

A.

B.

C.

ARC WELDING

ANSWERS TO TEST

I. A. 1

B. 8

C. 5

D. 2

E. 3

F. 4

G. 6

H. 7

II. Any ten of the following:

A. Never look at the welding arc with the naked eye.

B. Always use a head or face shield that is in good condition.

C. Wear suitable clothing to protect all parts of the body from arc burn and from spatter, such as leather gloves, long sleeved shirts with cuffs and collars buttoned and cuffs on pants turned down.

D. Do not strike an arc or weld until you are sure those in the vicintiy have protective equipment or will look the other direction.

E. Do not weld around combustible or flammable material.

F. Do not pick up hot metal.

G. Do not weld in confined places without adequate ventilation.

H. Always open the main switch or disconnect the plug when checking over the welder.

I. Do not leave the electrode holder on the welding table or in contact with a grounded metal surface.

J. Do not use worn or frayed cables.

K. Stand on dry footing when welding and keep the body insulated from the electrode, the electrode holder and the work.

L. Keep the shop clean, particularly around the welder.

III. Any three of the following:

A. AC (alternating current) - Current through the arc continually alternates or reverses itself 120 times per second on 60 cycle current.

B. Mig may use AC or DC current with a base wire filler material that is fed automatically into weld.

C. Tig may use AC or DC with a non-consumable tungsten electrode and an inert shielding gas.

D. DC (direct current) - Current flows in one direction.

IV. Any three of the following:

A. Mild steel

B. Cast iron

C. High carbon steel

D. Hard surfacing

V. A. Bare electrodes

B. Dusted

C. Flux coated

D. Extruded

VI. A. 1/8"

B. 5/32"

VII. A. American Welding Society

B. Designates that electrode is of the metal arc type.

C. Refers to the tensil strength of the deposited weld in thousands of pounds per square inch.

D. Shows some special characteristic of the electrode.

VIII. A. Scratching

B. Tapping

IX. A. Can be determined by size of electrode. Length should be equal to diameter of bare end of electrode.

B. Correct arc length can be determined by sound. With proper adjustment, gives a sharp crackling or frying sound.

X. A. Bead

B. Groove

C. Fillet

XI. A. Flat

B. Horizontal

C. Vertical

D. Overhead

XII. Any four of the following:

A. Plain butt joint

B. Grooved butt joint

C. Lap joint

D. Tee joint

E. Corner joint

F. Edge joint

XIII. Any three of the following:

A. Improper adjustment of machine

B. Dirty metal

C. Wrong size electrode

D. Improper arc length

E. Holding electrode at wrong angle

F. Wrong type of electrode

ELECTRODES

UNIT II

SECTION B

ELECTRODES

TERMINAL OBJECTIVE

After completion of this unit, the student should have a basic knowledge of electrodes. This knowledge will be evidenced by scoring at least eighty percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

I. Match terms associated with electrodes.

II. List two methods of identifying electrodes.

III. List five factors used in electrode classification.

IV. Identify six common electrodes and give their uses to the satisfaction of the instructor.

V. Determine from chart, various amperage settings for electrodes in different welding positions.

VI. List four reasons for different amperage settings.

VII. List three factors affecting choice of electrode uses.

VIII. List three factors involved in electrode storage.

IX. List three factors determining speed of movement of electrode.

X. List three rules affecting angle to hold electrode while welding.

ELECTRODES

SUGGESTED ACTIVITIES

I. Instructor:
  - A. Provide students with objectives
  - B. Provide students with information sheets
  - C. Discuss terminal and specific objectives
  - D. Discuss information sheets
  - E. Give test

II. Students:
  - A. Read objectives
  - B. Study information sheets
  - C. Take test

INSTRUCTIONAL MATERIALS

I. Included in this unit:
  - A. Objectives
  - B. Information sheets
  - C. Test
  - D. Answers to test

II. References:
  - A. Wakeman, McCoy, The Farm Shop, New York, New York, McMillan Co.
  - B. Jones, Shopwork On The Farm, New York, New York, McGraw Hill Book Co. Inc.
  - C. Althouse, Turnquist and Bowditch, Modern Welding, Homewood, Illinois, The Goodheart Wilcox Co.
  - D. Parker, Farm Welding, New York, New York, McGraw Hill Book Co, Inc.

ELECTRODES

INFORMATION SHEET

I. Terms and definitions:

   A. AWS CLASSIFICATION - System of classification using different numbers to identify types of electrodes.

   B. NEMA CLASSIFICATION - System of classification using color markings to identify some types of electrodes.

   C. PENETRATION - Depth of fusion zone below surface of base metal.

   D. POLARITY -

      1. Straight polarity - Electrons flow from electrodes to base metal.

      2. Reverse polarity - Electrons flow from base metal to electrode.

   E. ELECTRODE - Flux coated metal rod used in arc welding.

II. Two methods of identifying electrodes:

   A. Color markings

   B. AWS classification numbers

III. Factors used in electrode classification.

   A. Kind of metal to be welded.

   B. Required tensil strength and ductility of the weld.

   C. Suitable for alternating or direct current and polarity in case of direct current.

   D. Type of joint.

   E. Position in which the weld is to be made.

   F. Size of rod.

   G. Cooling

INFORMATION SHEET

IV. Common electrodes and their uses.

	TYPE OF WORK	ELECTRODE		CURRENT AND POLARITY	WELDING POSITION	PENETRATION	CHARACTERISTICS	USES
		AWS NO.5	NEMA COLOR					
A.	Mild Steel	E6010	None	DC Reverse Polarity	All	Deep	Leaves rough, rippled surface: slow burn off strong weld with much sparter.	All mild-steel welding very good for cutting. Best farm electrode.
B.		E6011	Blue Spot	All	All	Deep	Same as above	Same
C.		E6013	Brown Spot	All	All	Shallow	General purpose easy to use. Less burn through due to shallow penetration	All mild steel. Good for down welds on thin metal.
D.	Low Alloy Metals	7018		AC or DC Reverse Polarity	All	Varies	Smooth bead Very fluid slog	Used on hard to weld steel, flat or convex beads easy to obtain.
E.	Cast Iron		Orange Spot	AC or DC Reverse Polarity	All	Medium	Requires clean surface. Low heat	All cast iron, machinery parts, housing parts, etc
F.	Stainless Steel		Yellow group and end	All	All	Medium	Short arc electrode held 15° in direction of trode.	High to medium carbon alloy steel and most non ferrous metal.

INFORMATION SHEET

V. See chart below for various amperage settings for electrodes in different welding positions.

Thickness of metal	FLAT		Vertical		Horizontal and Overhead	
	Rod	Amps	Rod	Amps	Rod	Amps
1/16"	3/32"	65	3/32"	65	3/32"	65
1/8"	1/8"	100	1/8"	100	1/8"	100
3/16"	1/8"	115	1/8"	100	1/8"	130
1/4"	5/32"	130	1/8"	100	5/32"	150
5/16"	5/32"	140	1/8"	100	5/32"	160
3/8"	5/32"	160	5/32"	140	5/32"	160
1/2"	5/32"	175	5/32"	140	5/32"	170

INFORMATION SHEET

VI. Different amperage settings depend on:

- A. Size of electrode
- B. Thickness of metal
- C. Base metal composition
- D. Position of weld
- E. Kind of weld

VII. Factors affecting choice of the electrode.

- A. Kind of electrode
  - 1. AC
  - 2. DC Straight Polarity
  - 3. DC Reverse Polarity
- B. Kind of metal
- C. Thickness of metal
- D. Joint design

VIII. Factors involved in electrode storage.

- A. Store in dry place
- B. Protect from mechanical damage
- C. Use electrodes as purchased
- D. Store electrode as to size and type

IX. Factors determining speed of movement of electrode.

- A. Electrode should produce 3/4" to 1" of bead for each inch of electrode.
- B. Electrode should produce bead 2 to 3 times diameter of electrode.
- C. Electrode should penetrate to a depth of 1/3 to 1/2 the diameter of electrode.

INFORMATION SHEET

X. Rules affecting angle to hold electrode while welding.

A. When welding downhand, hold electrode at an angle of 15° to 20° forward in the direction of travel.

B. The thicker the flux the greater the angle of the electrode. (Some haavily coated electrodes are angled at 45°)

C. Increasing the angle pushes the molten metal back faster so it will not pile up under the electrode.

D. For maximum penetration, hold electrode at 90° angle to work.

E. The nearer parallel you hold the electrode to base metal, the less the penetration and the greater the elongation of the beads.

F. When welding heavy metal to thin metal, direct the arc toward the thin metal.

ELECTRODES

TEST

I. Match terms associated with electrodes to the correct definition.

___1. Straight Polarity

___2. NEMA Classification

___3. Electrode

___4. AWS Classification

___5. Reverse Polarity

___6. Penetration

A. Electrons flow from base metal to electrode.

B. System of classification using different numbers to identify types of electrodes.

C. Electrons flow from electrode to base metal.

D. Depth of fusion zone below surface of base metal.

E. System of classification using color markings to identify some types of electrodes.

F. Flux coated metal rod used in arc welding.

II. List two methods of identifying electrodes.

A.

B.

III. List five factors used in electrode classification.

A.

B.

C.

D.

E.

IV. Identify six common electrodes and give their uses.

A.

B.

C.

D.

E.

F.

Thickness of metal	Flat		Vertical		Horizontal and overhead	
	Rod	Amps	Rod	Amps	Rod	Amps
1/16"	3/32"	65	3/32"	65	3/32"	65
1/8"	1/8"	100	1/8"	100	1/8"	100
3/16"	1/8"	115	1/8"	100	1/8"	130
1/4"	5/32"	130	1/8"	100	5/32"	150
5/16"	5/32"	140	1/8"	100	5/32"	160
3/8"	5/32"	160	5/32"	140	5/32"	160
1/2"	5/32"	175	5/32"	140	5/32"	170

V. From chart above, find the amperage setting for the following.

A. 1/8" electrode used in flat position on 1/8" metal. ______________

B. 5/32" electrode used in overhead position on 3/8" metal. _________

C. 3/32" electrode used in horizontal position on 1/16" metal. ______________

VI. List four reasons for different amperage settings.

A.

B.

C.

D.

VII. List three factors affecting choice of electrode uses.

A.

B.

C.

VIII. List three factors involved in electrode storage.

A.

B.

C.

IX. List three factors determining speed of movement of electrodes.

A.

B.

C.

X. List three rules affecting angle to hold electrode while welding.

A.

B.

C.

ELECTRODES

ANSWERS TO TEST

I. 1. C

2. E

3. F

4. B

5. A

6. D

II. A. Color markings

B. Number markings

III. Any five of the following:

A. Kind of metal to be welded.

B. Required tensil strength and ductility of the weld.

C. Suitable for alternating or direct current and polarity in case of direct current.

D. Type of joint.

E. Position in which the weld is to be made.

F. Size of rod

G. Cooling

IV. A. Mild steel - E6010 - All mild steel welding is very good for cutting. Best farm electrode.

B. E6011 - Same as E6010

C. E6013 - All mild steel. Good for down welds on thin metal.

D. 7018 - Used on hard to weld steel.Flat or convex beads easy to obtain.

E. Cast Iron - All cast iron. Machinery parts, housing parts, etc.

F. Stainless Steel - High to medium carbon alloy steel and most non-ferrous metal.

V. A. 100 amp

B. 160 amp

C. 65 amp

VI. Any four of the following:

A. Size of electrode

B. Thickness of metal

C. Base metal composition

D. Position of weld

E. Kind of weld

VII. Any three of the following:

A. Kind of electrode

B. Kind of metal

C. Thickness of metal

D. Joint design

VIII. Any three of the following:

A. Store in dry place

B. Protect from mechanical damage

C. Use electrodes as purchased

D. Store electrodes as to size and type

IX. A. Electrode should produce 3/4" to 1" of bead for each inch of electrode.

B. Electrode should produce bead 2 to 3 times diameter of electrode.

C. Electrode should penetrate to a depth of 1/3 to 1/2 the diameter of electrode.

X. Any three of the following:

A. When welding downhand, hold electrode at an angle of 15° to 20° forward in the direction of travel.

B. The thicker the flux the greater the angle of the electrode. (Some heavily coated electrodes are angled at 45°)

C. Increasing the angle pushes the molten metal back faster so it will not pile up under the electrode.

D. For maximum penetration, hold electrode at 90° angle to work.

E. The nearer parallel you hold the electrode to base metal, the less the penetration and the greater the elongation of the beads.

F. When welding heavy metal to thin metal, direct the arc toward the thin metal.

POSITION WELDING

UNIT III

SECTION B

POSITION WELDING

TERMINAL OBJECTIVE

After completion of this unit, the student should be able to weld in all positions. This knowledge will be evidenced through demonstration and by scoring at least eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

I. Match terms associated with position welding.

II. List four positions welds can be made in.

III. Distinguish between straight and reverse polarity.

IV. Name five factors to be considered when selecting an electrode for a particular purpose.

V. Name the two types of adjustment found on arc welding machines.

VI. Name four types of welds.

VII. Name four pieces of common safety equipment needed in arc welding.

VIII. Name five types of weld joints.

IX. Demonstrate the ability to:

  A. Strike and establish an arc

  B. Run continuous stringer beads

  C. Make a pad of beads in flat position

  D. Run beads in vertical position

  E. Butt welds

  F. Lap weld

  G. Single pass fillet weld

H. Fillet weld, multiple pass

I. Corner weld

J. Vertical weld up

K. Horizontal weld in vertical position

POSITION WELDING

SUGGESTED ACTIVITIES

I. Instructor:

   A. Provide students with objective sheet.

   B. Provide students with information sheet.

   C. Make transparencies.

   D. Discuss terminal and specific objectives.

   E. Discuss information sheet.

   F. Demonstrate and discuss the procedures outlined in the job sheets.

   G. Give test.

II. Students:

   A. Read objective sheet.

   B. Study information sheet.

   C. Demonstrate the ability to accomplsih the procedures outlined in the job sheets.

   D. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

   A. Objective sheets

   B. Information sheets

   C. Transparency masters

      1. TM 1 - Parts of a Weld

      2. TM 2 - Types of Welds

      3. TM 3 - Types of Joints

D. Job sheets

1. Job sheet #1 - Striking and Establishing Arc
2. Job sheet #2 - Running Continuous Stringer Beads
3. Job sheet #3 - Making A Pad of Beads in Flat Position
4. Job sheet #4 - Running Beads in Vertical Position
5. Job sheet #5 - Butt Welds
6. Job sheet #6 - Lap Weld
7. Job sheet #7 - Single Pass Fillet Weld
8. Job sheet #8 - Fillet Weld, Multiple Pass
9. Job sheet #9 - Corner Weld
10. Job sheet #10- Vertical Weld Up
11. Job sheet #11- Horizontal Weld In Vertical Position

E. Test

F. Answers to test

II. References:

A. Parker, Marvin M., Farm Welding, New York, McGraw Hill Book Company.

B. Althouse, Andrew Turnquist and Bowditch, Modern Welding, South Holland, Illinois, Goodheart Wilcox Co.

C. Jones, Mack M., Shopwork On The Farm, New York, New York, McGraw Hill Book Co.

D. Griffin, Ivan H. and Roden, Edward M., Welding Processes, Albany, New York, Delmar Publishers

E. Wakeman, T.J. and Vernon Lee McCoy, The Farm Shop, New York, New York, The MacMillan Co.

F. Phipps, Lloyd J., Mechanics in Agriculture, Danville, Illinois, The Interstate Printers and Publishers.

POSITION WELDING

INFORMATION SHEET

I. Terms and definitions:

A. ARC - The flow of electricity across a gap from the tip of the electrode to the metal being welded.

B. BASE METAL - Metal to be welded.

C. ARC LENGTH - The distance from the end of the electrode to the point where the arc makes contact with the work.

D. CRATER - A depression in the face of a weld, usually at the termination of an arc.

E. POROSITY - Presence of gas pockets or voids in the metal.

F. SPATTER - Metal articles given off during welding which do not form a part of weld.

G. FLUX - A chemical used to promote fusion of metals during the welding process.

H. SLAG - Non-metallic crust covering weld.

I. PUDDLE - Portion of weld that is molten at the place heat is supplied.

J. UNDER CUT - A depression at the toe of the weld which is below the surface of the base metal.

II. Four positions in which welds can be made in.

A. Flat

B. Vertical

C. Horizontal

D. Overhead

III. Two types of polarity.

A. Straight Polarity - Connecting DC to cause electrons to flow from the electrode to the base metal.

B. Reverse Polarity - Connecting DC causing electrons to flow from work to the electrode.

INFORMATION SHEET

IV. Factors to consider when selecting an electrode.

- A. Base metal strength properties
- B. Base metal composition
- C. Welding position
- D. Welding current
- E. Joint design
- F. Thickness of metal
- G. Specifications
- H. Job conditions

V. Two types of adjustments found on arc welding machines.

- A. Polarity
- B. Amperage

VI. Four types of welds.

- A. Bead
- B. Fillet
- C. Groove
- D. Plug

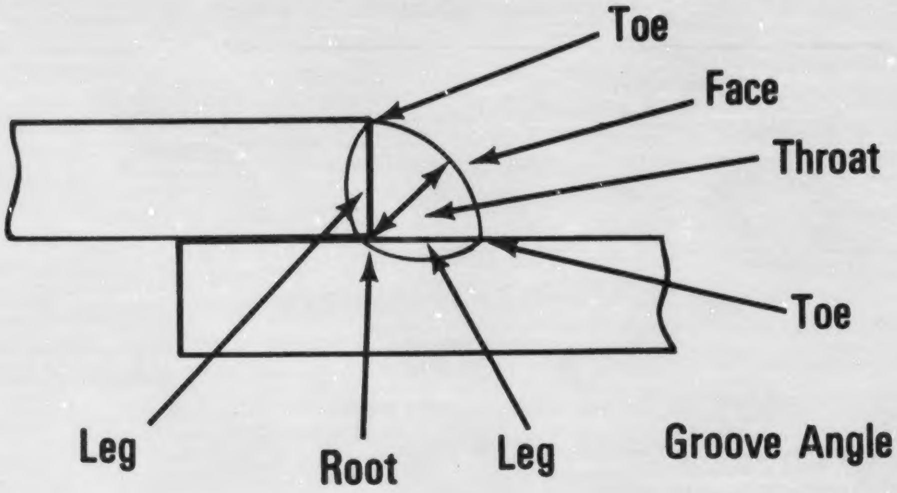
VII. Common safety equipment needed in arc welding.

- A. Shield or helmet
- B. Gloves
- C. Cape sleeves
- D. Clear goggles
- E. Pliers
- F. Chipping hammer
- G. Boots

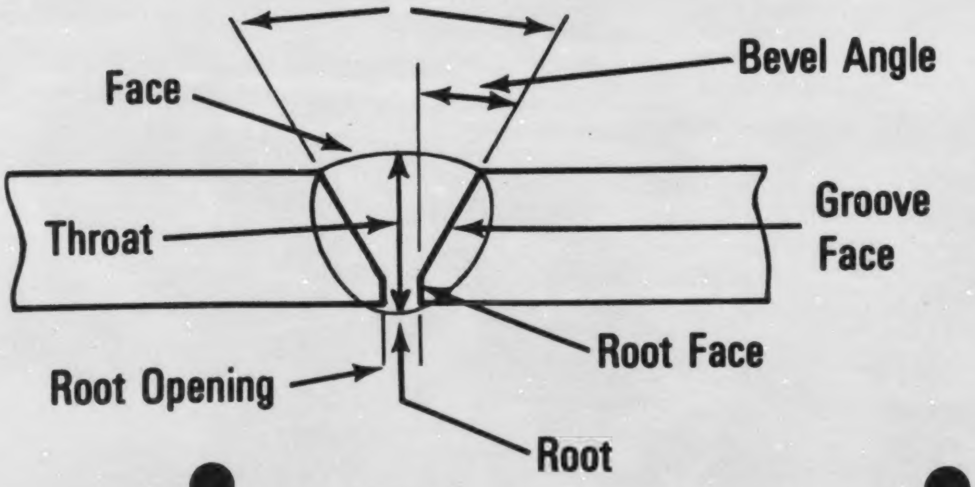
VIII. Types of weld joints.

- A. Butt
- B. Corner
- C. Tee
- D. Lap
- E. Edge

Parts of a Weld

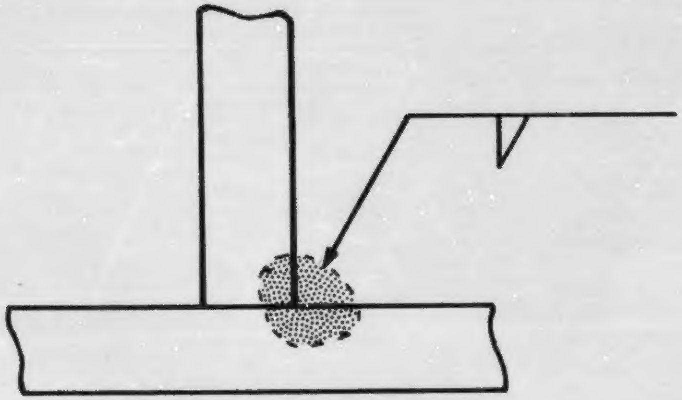

Toe
Face
Throat
Toe
Leg
Root
Leg

FILLET WELD

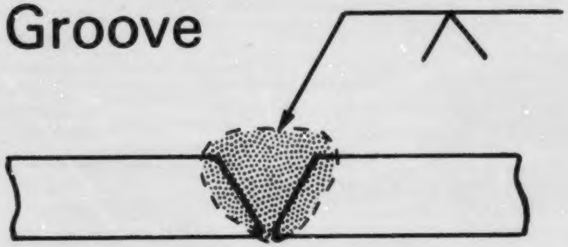

Groove Angle
Bevel Angle
Face
Throat
Groove Face
Root Face
Root Opening
Root

GROOVE WELD

Types of Welds

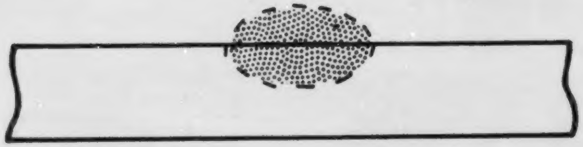


Fillet

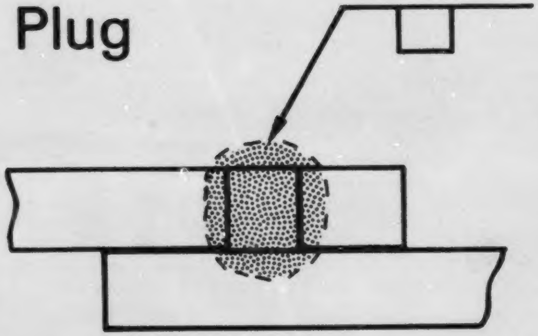


Groove

END VIEW



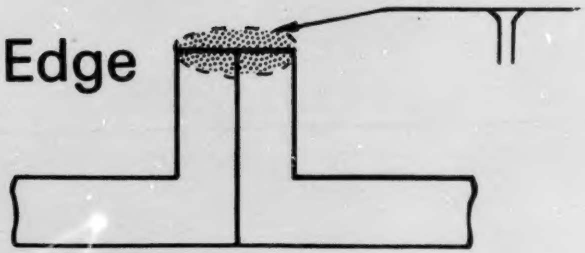
Bead



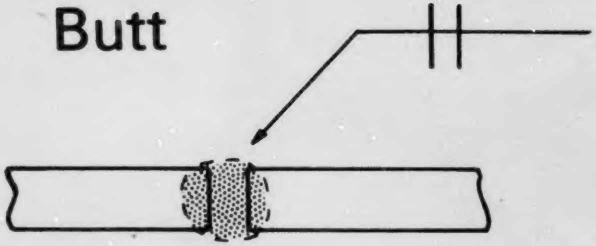
Plug

Types of Joints

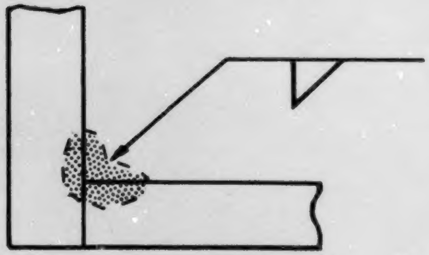
Edge



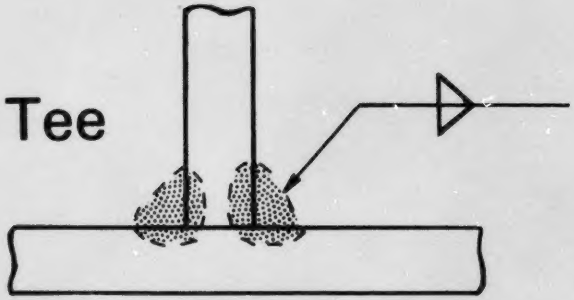
Butt



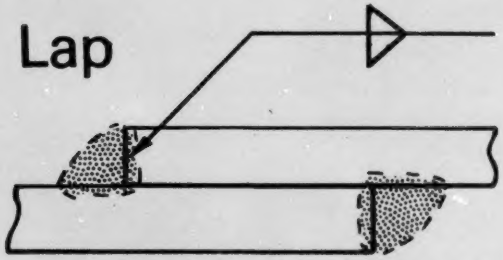
Corner



Tee



Lap



POSITION WELDING

JOB SHEET #1 - STRIKING AND ESTABLISHING ARC

I. Tools and equipment needed:

A. Welder

B. Gloves, helmet, safety goggles, cape sleeves and apron

C. Chipping hammer

D. Wire brushes

E. Pliers

II. Materials:

A. Steel plate 3/16" X 6" X 6"

B. 1/8" E6013 or E6011 Electrode

III. Procedure:

A. Prepare metal for welding.

B. Check machine for proper polarity. (DC only)

C. Adjust amperage for size electrode and metal being used.

D. Hold electrode 1" above metal at the point where weld is to be started.

E. Lower helmet over your eyes.

F. Turn on machine.

G. Gently lower electrode and scratch surface as striking a match.

H. As soon as arc is formed, raise electrode to the proper distance from metal. (Distance equal to the diameter of bare end of electrode)

I. Move electrode slowly along metal to allow bead to form 1 inch long.

J. Raise quickly to stop arc.

K. Practice striking arc until it can be done with ease.

JOB SHEET #1

L. If electrode sticks to metal turn off machine immediately.

M. Turn in metal to instructor for grade.

POSITION WELDING

JOB SHEET #2 - RUNNING CONTINUOUS STRINGER BEADS

I. Tools and equipment needed:

  A. Welder

  B. Gloves, helmet, safety goggles, cape sleeves and apron

  C. Chipping hammer

  D. Wire brush

  E. Pliers

II. Materials:

  A. Steel plate 3/16" X 6" X 9" to 12"

  B. 1/8" or 5/32", E6011 or E6013 electrodes

III. Procedure:

  A. Prepare metal for welding.

  B. Check machine for proper polarity.

  C. Adjust amperage for size electrode used and metal thickness.

  D. Turn on machine.

  E. Establish arc, hold electrode at 15° to 20° angle in direction of travel.

  F. Run a continuous stringer bead ½" from edge of plate the entire length of the plate or until electrode is consumed.

  G. Chip slag from weld and check for width, height and constance of bead.

  H. Run additional beads ½" intervals striving to keep each bead straight.

  I. Check the arc length and rate of travel constantly in order to produce smooth uniform beads.

  J. Continue running beads until they can be done with consistancy.

POSITION WELDING

JOB SHEET #3 - MAKING A PAD OF BEADS IN FLAT POSITION

I. Tools and equipment needed:

A. Welder

B. Gloves, helmet, safety goggles, cape sleeves and apron

C. Chipping hammer

D. Wire brush

E. Pliers

II. **Material:**

A. Steel plate 3/16" X 6" X 6" to 9"

B. 1/8" or 5/32" E6011 or E6013 electrodes

III. **Procedure:**

A. Prepare metal for welding.

B. Check machine for proper polarity.

C. Adjust amperage for size electrode and metal thickness.

D. Turn on machine.

E. Establish arc.

F. Hold electrode at a 15° to 30° angle in direction of travel.

G. Run a bead 1/2" from side of plate the entire length of plate.

H. Chip away slag and examine this first bead checking for surface appearance, slag holes, excessive build up of bead and excessive spatter.

I. Readjust machine if bead appearance warrants.

J. Second bead is run along first bead overlapping 1/3 of the first bead.

K. Chip off slag after each bead.

L. Turn in to instructor for grade.

POSITION WELDING

JOB SHEET #4 - RUNNING BEADS IN VERTICAL POSITION

I. Tools and equipment needed:

- A. Welder
- B. Gloves, helmet, safety goggles, cape sleeves and apron
- C. Wire brush
- D. Chipping hammer
- E. Pliers

II. Materials:

- A. Steel plate 3/16" X 6" X 6"
- B. 1/8" E6013 or E6011 electrodes

III. Procedure:

- A. Prepare metal for welding.
- B. Check machine for proper polarity.
- C. Adjust amperage for size electrode, thickness of metal and position in which weld is to be made.
- D. Place metal to be welded in a vertical position at eye level.
- E. Hold electrode above corner in which you will start.
- F. Turn on machine.
- G. Lower welding hood.
- H. Strike arc and begin weld in upper left or right hand corner .
- I. Hold electrode at 15° to 20° angle in direction of travel. (down)
- J. Move electrode fast enough to stay ahead of the puddle maintaining a very short arc.
- K. After completion of the first bead, chip slag and observe appearance of weld.

JOB SHEET #4

L. Run beads 1" apart over entire surface striving to keep beads as straight as possible.

M. Repeat as necessary to secure good job of welding.

N. Turn in finished plate to instructor for grade.

To instructor: It may be necessary for student to weld a number of plates before acceptable work can be accomplished.

POSITION WELDING

JOB SHEET #5 - BUTT WELDS

I. Tools and equipment:

- A. Welder
- B. Gloves, helmet, safety goggles, cape sleeves and apron
- C. Wire brush
- D. Chipping hammer
- E. Pliers

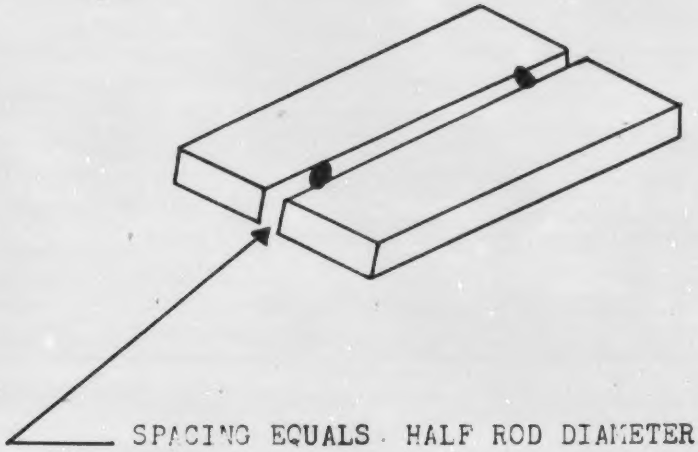
II. Materials needed:

- A. Two steel plates ¼" X 1½" to 2" X 9"
- B. 5/32" E6013 electrodes

III. Procedure:

- A. Prepare metal for welding.
- B. Check machine for proper polarity. (DC only)
- C. Adjust amperage for size electrode, metal thickness and position of weld.
- D. Lower helmet.
- E. Tack weld as shown in diagram.
- F. Make weld with slight amount of weaving to accomodate width of the joint.
- G. Cool, clean and check the weld for uniform appearance.
- H. Check penetration of weld by placing in vise and bending toward face or welded side of penetration. Should be a little more that one half thickness of metal.
- I. Continue welding plate until satisfactory weld is accomplished.
- J. Turn in to instructor for grade.

JOB SHEET #5



SPACING EQUALS HALF ROD DIAMETER

POSITION WELDING

JOB SHEET #6 - LAP WELD

I. Tools and equipment needed:

   A. Welder

   B. Gloves, helmet, safety goggles, cape sleeves and apron

   C. Wire brush

   D. Chipping hammer

   E. Pliers

II. Materials needed:

   A. Two steel plates 3/16" X 2" X 9"

   B. 5/32" #E6013 electrodes

III. Procedure:

   A. Prepare metal for welding.

   B. Set up metal as shown in diagram 1.

   C. Check machine for proper polarity.

   D. Adjust amperage for size electrode, metal thickness and position of weld.

   E. Check and make sure that the plates are flat and in immediate contact with each other.

   F. Weld this joint with the electrode at an angle of 45° from the horizontal.

   G. Make sure the weld metal penetrates the root of the joint and that weld metal builds up to the top of the lapping plate.

   H. Cool and clean bead and examine for the following traits.

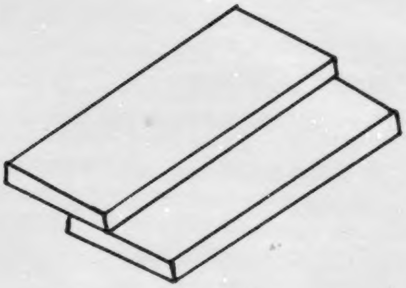
      1. The lines of fusion with top and bottom plates should be straight.

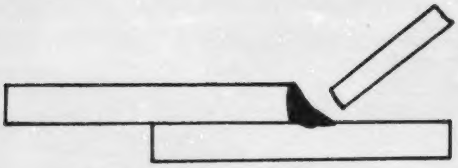
      2. There should be a smooth transition from weld to the plate.

JOB SHEET #6

I. Continue to make this type of joint until beads of uniform appearance can be made.

J. Turn in finished weld to instructor for grade.





POSITION WELDING

JOB SHEET #7 - SINGLE PASS FILLET WELD

I. Tools and equipment needed:

   A. Welder

   B. Gloves, helmet, safety goggles, cape sleeves and apron.

   C. Wire brush

   D. Chipping hammer

   E. Pliers

II. Materials:

   A. Two steel plates, 3/16" or ¼" X 3" X 9" to 12"

   B. 5/32" E6013 electrodes

III. Procedure:

   A. Prepare metal for welding.

   B. Check machine for proper polarity.

   C. Adjust amperage.

   D. Lower helmet.

   E. Tack weld (Be sure these are strong enough to hold plates in alignment while welding but not large enough to affect the finished bead.)

   F. Hold electrode at 45^{o} to the horizontal.

   G. Use a weave motion which will deposit as much metal on the upright plate as on base metal.

   H. Clean each completed weld and examine for surface appearance.

      1. Look for poor fusion along both plates.

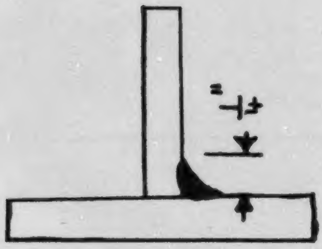
      2. Look for holes in weld which are a sign of too long an arc.

      3. Look for under cuttings of upright plate which is a sign of too long an arc or too high a rate of travel.

JOB SHEET #7

4. Check for penetration by bending upright plate down against base plate or until it breaks and check for root penetration.

I. After satisfactory fillet weld has been made turn in to instructor for grade.



POSITION WELDING

JOB SHEET #8 - FILLET WELD, MULTIPLE PASS

I. Tools and materials needed:

A. Welder

B. Gloves, helmet, safety goggles, cape sleeves and apron

C. Wire brush

D. Chipping hammer

E. Pliers

II. Materials:

A. Two steel plates ½" X 2" X 9" to 12"

B. 5/32" E6013 electrodes

III. Procedures:

A. Prepare metal to be welded.

B. Check machine for proper polarity. (DC only)

C. Adjust amperage for size electrode, metal thickness and position of weld.

D. Tack weld as with single pass fillet weld.

E. Chip and clean after each bead.

F. Hold electrode at a 45° angle to the horizontal to run first bead.

G. Second bead is run at a 70° angle to the base plate.

H. Third bead is run at a 30° angle to the base plate. (It is best to alternate welds on each side of plate to cut down on distortion. Example: Run first bead on one side of plate, then run first bead on other side.)

I. Look for holes in welds, excessive under cutting that might weaken the weld.

J. When satisfactory weld has been accomplished, turn in to instructor for grade.

POSITION WELDING

JOB SHEET #9 - CORNER WELD

I. Tools and equipment needed:

   A. Welder

   B. Gloves, helmet, safety goggles, cape sleeves and apron

   C. Chipping hammer

   D. Wire brushes

   E. Pliers

II. Materials:

   A. Steel plate 3/8" X 2" X 9" to 12"

   B. 5/32" E6010

III. Procedure:

   A. Prepare metal for welding.

   B. Check machine for proper polarity.

   C. Adjust amperage for size electrode, thickness of metal and position in which weld is to be made.

   D. Set up metal as shown in illustration I on second sheet.

   E. Make the weld in three or more passes as shown in illustration II, cleaning after each pass.

   F. When making the final pass, be sure bead does not overhang plate edges.

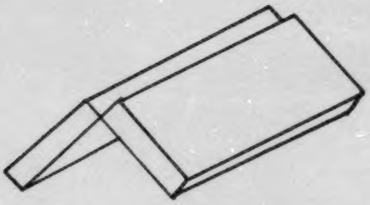
   G. Check the weld for uniformity and smooth appearance.

   H. Test the weld by placing the piece of metal on an anvil and hammering it flat in order to examine root fusion and penetration.

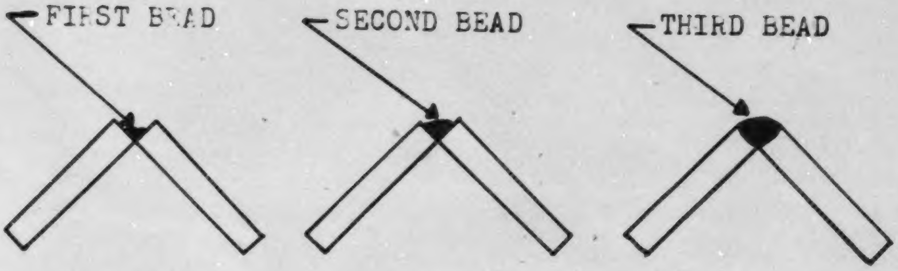
   I. When satisfactory weld has been made, turn in to instructor for grade.

JOB SHEET #9

I.



II.


FIRST BEAD
SECOND BEAD
THIRD BEAD

POSITION WELDING

JOB SHEET #10 - VERTICAL WELD UP

I. Tools and equipment needed:

  A. Welder

  B. Gloves, helmet, safety goggles, cape sleeves and apron

  C. Chipping hammer

  D. Wire brushes

  E. Pliers

II. Materials needed:

  A. Steel plate 3/16" X 6" X 6"

  B. 1/8" E6011 or E6012 electrode

III. Procedure:

  A. Prepare metal for welding.

  B. Check machine for proper polarity.

  C. Adjust amperage for size electrode, thickness of metal and position in which weld is to be made.

  D. Place metal to be welded in vertical position at eye height.

  E. Hold electrode at an approximate right angle to the vertical surface.

  F. Establish and hold a short arc.

  G. Direct the arc on lower edge until a crater slightly larger than the diameter of the electrode is formed, then move slowly up the surface and deposit a straight bead weld.

  H. Be sure to hold electrode at 90° angle when welding.

  I. If metal begins to pile up in the bead, this may be caused by one of two things.

    1. Moving electrode too slowly.

    2. Directing electrode upward.

JOB SHEET #10

J. Chip and wire brush after each bead.

K. Run beads approximately ½" apart until welds become uniform.

L. When satisfactory beads have been accomplished, turn in to instructor for grade.

POSITION WELDING

JOB SHEET #11 - HORIZONTAL WELD IN THE VERTICAL POSITION

I. Tools and equipment needed:

  A. Welder

  B. Gloves, helmet, safety goggles, cape sleeves and apron

  C. Chipping hammer

  D. Wire Brushes

  E. Pliers

II. Materials:

  A. Steel plate 3/16" X 6" X 6"

  B. 1/8" E6011 or E6013 electrode

III. Procedure:

  A. Prepare metal for welding.

  B. Check machine for proper polarity.

  C. Adjust amperage for size electrode, metal thickness and position of weld.

  D. Place metal to be welded in a vertical position approximately eye height.

  E. Hold electrode at 90° angle to vertical surface and tilted about 15° in direction of travel.

  F. Strike arc at the left end of plate (assuming you are left-handed) and deposit a striaght bead along the vertical surface in a horizontal line.

  G. If sogging is a problem, reduce amperage setting on welder.

  H. Run beads approximately ½" apart.

  I. Chip and clean each bead upon completion.

  J. When satisfactory beads can be run, turn metal in to instructor for grade.

POSITION WELDING

TEST

I. Match the terms to the correct definition.

___A. Metal to be welded.

___B. A depression in the face of a weld, usually at the termination of an arc.

___C. The flow of electricity across a gap from the tip of the electrode to the metal being welded.

___D. A chemical used to promote fusion of metals during the welding process.

___E. Portion of the weld that is molten at the place heat is supplied.

___F. Presence of gas pockets or voids in the metal.

___G. A depression at the toe of the weld which is below the surface of the base metal.

___H. Non-metallic crust covering weld.

1. Slag
2. Flux
3. Porosity
4. Crater
5. Under Cut
6. Base Metal
7. Puddle
8. Arc

II. List four positions welds can be made in.

A. C.

B. D.

III. Distinguish between straight and reverse polarity.

A. Straight -

B. Reverse -

IV. Name five factors to be considered when selecting an electrode for a particular purpose.

A.

B.

C.

D.

E.

V. Name the two types of adjustments found on arc welding machines.

A.

B.

VI. Name four types of welds.

A. C.

B. D.

VII. Name four pieces of common safety equipment needed in arc welding.

A.

B.

C.

D.

VIII. Name five types of weld joints.

A.

B.

C.

D.

E.

POSITION WELDING

ANSWERS TO TEST

I. A. 6

B. 4

C. 8

D. 2

E. 7

F. 3

G. 5

H. 1

II. A. Flat

B. Vertical

C. Horizontal

D. Overhead

III. A. Connecting DC to cause electrons to flow from the electrode to the base metal.

B. Connecting DC causing electrons to flow from work to the electrode.

IV. Any five of the following:

A. Base metal strength properties

B. Base metal composition

C. Welding position

D. Welding current

E. Joint design

F. Thickness of metal

G. Specifications

H. Job conditions

V. A. Polarity
   B. Amperage

VI. A. Bead
   B. Fillet
   C. Groove
   D. Plug

VII. Any four of the following:
   A. Shield or helmet
   B. Gloves
   C. Cape sleeves
   D. Clear goggles
   E. Pliers
   F. Chipping hammer
   G. Boots

VIII. A. Butt
   B. Corner
   C. Tee
   D. Lap
   E. Edge

GAS METAL ARC WELDING

UNIT IV

SECTION B

GAS METAL ARC WELDING

TERMINAL OBJECTIVE

After completion of this unit, the student should have a basic understanding of gas metal arc welding, be able to start up and shut down the equipment used and run basic welds. This knowledge will be evidenced through demonstration and by scoring at least eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

I. Match terms associated with gas metal arc welding process to the correct definition.

II. List five advantages of gas metal arc welding.

III. Name three types of metal transfer.

IV. List six pieces of equipment needed for gas metal arc welding.

V. Name five types of shielding gases.

VI. Choose from a list, factors involved in selecting filler wires.

VII. Name two types of welding wire.

VIII. Name five types of metal which can be welded with gas metal arc welding.

IX. Name the four welding positions which a gas metal arc welder can be used.

X. Choose from a list, common mistakes made in welding.

XI. List the three steps in starting a bead with gas metal arc welder.

XII. List the two types of power sources.

XIII. List four effects of inert gases on weld.

XIV. Demonstrate the abiltiy to:

    A. Set up and shut down gas metal arc welder.

    B. Run practice beads on flat metal.

C. Construct a single pass T joint fillet weld in the horizontal position.

D. Lap joint in vertical down position.

E. Corner weld in horizontal position.

GAS METAL ARC WELDING

SUGGESTED ACTIVITIES

I. Instructor:

- A. Provide students with objectives.
- B. Provide students with information and job sheets.
- C. Discuss terminal and specific objectives.
- D. Discuss information sheet.
- E. Demonstrate and discuss procedure set forth in job sheet.
- F. Give test.

II. Student:

- A. Read objective sheet.
- B. Study information sheet.
- C. Demonstrate the ability to accomplish the procedures outlined in the job sheets.
- D. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

- A. Objectives
- B. Information sheets
- C. Transparency masters
  - 1. TM 1 - GMAW Equipment
  - 2. TM 2 - GMAW Process
- D. Job sheets
  - 1. Job sheet #1 - Set Up and Shut Down Gas Metal Arc Welder

2. Job sheet #2 - Running Practice Beads On Flat Metal
3. Job sheet #3 - Construct A Single Pass T Joint Fillet Weld In The Horizontal Position
4. Job sheet #4 - Lap Joint In Vertical Down Position
5. Job sheet #5 - Corner Weld In Horizontal Position

E. Test

F. Answers to test

II. References:

A. American Welding Society Specifications on GMAW Wire Number A 5.18 and A 5.20, American Welding Society, Miami, Florida.

B. Ahella, F.J. and Sullivan, R.P., Gas Metal Arc Welding of Stainless Steel Using Short Circular Transfer, Newark, New Jersey, Linde Division, Union Carbide Corp.

C. Hobart Welding School Workbook, Troy, Ohio, Hobart School of Welding Technology.

D. How To Do Manual Metal Inert Gas Welding, Newark, New Jersey, Linde Division, Union Carbide Corp.

E. Jefferson, T.B. and Woods, Gorham, Metals and How To Weld Them, Cleveland, Ohio, James F. Lincoln Arc Welding Foundation.

F. The Welding Encyclopedia, Morton Grove, Illinois, Welding Engineer Publishing Co., Monticello Books.

G. Modern Welding, South Holland, Illinois, Goodheart Wilcox Co., Inc.

GAS METAL ARC WELDING

INFORMATION SHEET

I. Terms and definitions:

   A. SPRAY ARC - Metal transfers across the arc as a fine spray of several hundred droplets per second.

   B. SHORT CIRCUIT METHOD OF TRANSFER - Metal transfers across the arc in large droplets at the rate of 100 droplets per second or less.

   C. STICK OUT - The distance from the contact tip of the gun to the end of the electrode.

   D. SLOPE - Refers to the shape of the volt-ampere curve.

   E. WHISKERS - Short lengths of wire that penetrate through root gap of weld.

   F. SHIELDING GASES - Gases used to displace air around weld while in progress to prevent contamination of weld.

II. Advantages of gas metal arc welding.

   A. Arc visible to welder

   B. No slag

   C. High disposition rate

   D. Weld metal of low hydrogen quality

   E. Greatly reduced distortion of gage metal

   F. Can be used to weld most metals

   G. Wide range of metal thickness can be welded without changing wire size.

III. Three types of metal transfers.

   A. Spray

   B. Globular

   C. Short circuiting

IV. Equipment needed for gas metal arc welding.

   A. Booth

INFORMATION SHEET

- B. Bench
- C. Ventilation system
- D. Combination gas, water, wire and cable control wire to the gun
- E. Inert gas cylinder
- F. Cylinder regulator and flowmeter
- G. Special electrode holder
- H. Remote current control
- I. Electrode wire feed unit
- J. Reel of electrode wire

V. Types of shielding gases.

- A. Argon
- B. Helium
- C. Carbon Dioxide
- D. Argon-oxygen
- E. Argon-helium
- F. Argon Carbon Dioxide
- G. Argon-helium-carbon dioxide

VI. Factors involved in selecting filler wires.

- A. Metal to be welded
- B. Metal thickness and joint design
- C. Metal surface condition
- D. Specifications of the job

VII. Two types of welding wire.

- A. Solid wire
- B. Flux cored wire

INFORMATION SHEET

VIII. Types of metal which can be welded with gas metal arc welding.

A. Mild steel

B. Stainless steel

C. Aluminum

D. Magnesium

E. Alloy steels

F. Copper alloys

IX. Welding positions which can be used with gas metal arc welding.

A. Flat

B. Horizontal

C. Vertical

D. Overhead

X. Common mistakes made in welding.

A. Cold lapping

B. Excessive penetration

C. Insufficient penetration

D. Whiskers

E. Poor appearance

F. Burn through

G. Bad tie in

XI. Proper steps in starting a bead with gas metal arc welder.

A. Touch electrode end to the proper place on metal with helmet up.

B. Lower helmet

C. Press start button on torch

INFORMATION SHEET

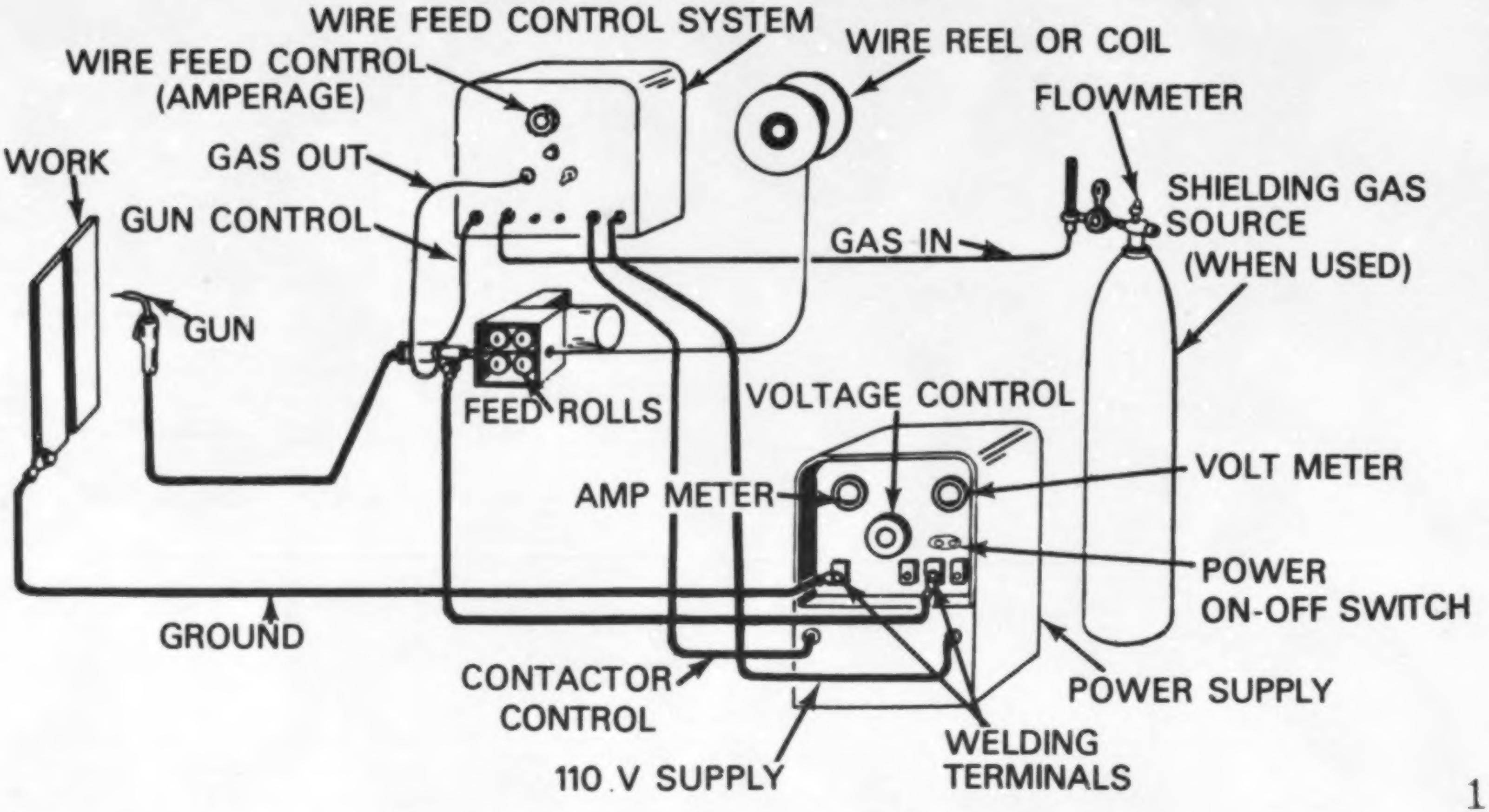
XII. Two types of power sources.

- A. Motor generator
- B. Transformer-rectifier

XIII. Effect on inert gases on welds.

- A. Influence shape of weld
- B. Determine amount of current needed
- C. Amount of spatter
- D. Amount of penetration

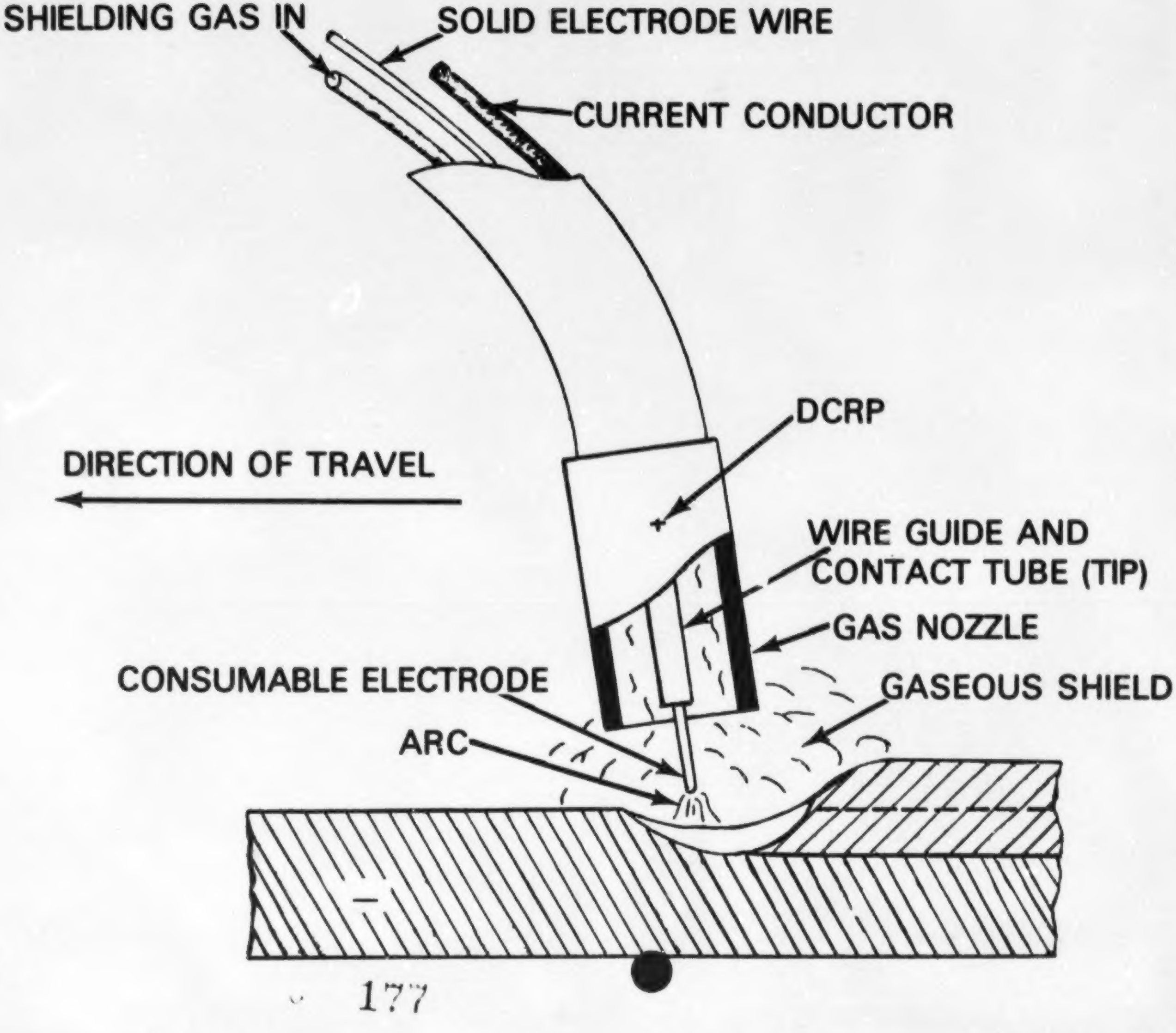
GMAW Equipment


WIRE FEED CONTROL SYSTEM
WIRE REEL OR COIL
WIRE FEED CONTROL (AMPERAGE)
FLOWMETER
WORK
GAS OUT
SHIELDING GAS SOURCE (WHEN USED)
GUN CONTROL
GAS IN
GUN
FEED ROLLS
VOLTAGE CONTROL
AMP METER
VOLT METER
POWER ON-OFF SWITCH
GROUND
CONTACTOR CONTROL
POWER SUPPLY
WELDING TERMINALS
110 V SUPPLY

*DCRP- MOST GTAW APPLICATIONS

(NOTE: SOME FLUXCORED GTAW IS DONE WITH DCSP)

GMAW Process


SHIELDING GAS IN
SOLID ELECTRODE WIRE
CURRENT CONDUCTOR
DCRP
DIRECTION OF TRAVEL
WIRE GUIDE AND CONTACT TUBE (TIP)
GAS NOZZLE
CONSUMABLE ELECTRODE
GASEOUS SHIELD
ARC
−

GAS METAL ARC WELDING

JOB SHEET #1 - SET UP AND SHUT DOWN GMAW EQUIPMENT

I. Equipment and materials needed:

A. GMAW power supply, feeder wire and gun (air-cooled)

B. Shielding gas

1. For mild steel - CO_2; C-25

2. For stainless steel - Argon, C-25; Helium-Argon-CO_2; Argon-Oxygen (1-5%)

3. For aluminum, copper, magnesium-argon, helium or argon-helium mixes.

NOTE: Flux cored welding is for steel only with or without shielding gas.

C. Electrode filler wire

1. Solid or cored - Determined by base metal to be welded.

2. Wire diameters

a. Short arc - .030", .035", .045"

b. Spray arc - .045", 1/16", 3/64", 3/32"

c. Flux cored - .045", 1/16", .68", 5/64", 3/32", 7/64", 1/8"

D. Current settings

1. Short arc - DCRP-50-250 amps

2. Spray arc - DCRP-250-450 amps

3. Flux cored - DCRP-120-650 amps; DCSP-120-650 amps

E. Voltage setting

1. Short arc - 12-30 arc volts

2. Spray arc - 24-36 arc volts

3. Flux cored - 20-38 arc volts

JOB SHEET #1

II. Set up procedure:

A. Set up power supply controls as follows:

1. Start welding machine - Push start switch or start engine if engine driven.

2. Set machine controls

a. Voltage

b. Inductance (if equipped)

c. Slope (if equipped)

B. Set up wire pad and shielding gas controls.

1. Set up wire feed

a. Correct size and type of wire

b. Correct size feed roll or rolls

c. Inch wire out to gun using incher control if equipped

d. Adjust tension of feed rolls

NOTE: Tension should be tight enough to feed wire but should not deform or mark wire.

e. Turn on power switch

2. Set up and adjust shielding gas controls (if used)

a. Blow out cylinder valve to remove any dirt or foreign material.

b. Mount gas flowmeter to cylinder in a vertical position.

c. Crack cylinder valve slowly.

NOTE: Check for leaks using soapy water. Ivory soap should be used.

d. Turn wire speed control to zero or release pressure on feed rolls.

e. Open flowmeter adjusting valve slowly while depressing gun trigger.

JOB SHEET #1

f. Adjust desired flow rate (c.f.h.) and release trigger. (Figure 1)

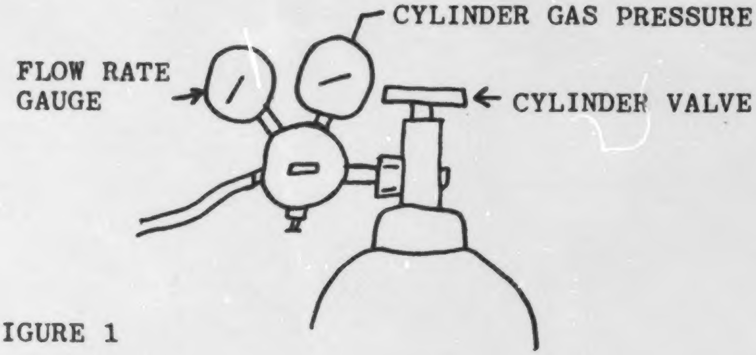


FIGURE 1

NOTE: This is accurate only if gas in cylinder exceeds p.s.i. and is mounted vertically.

3. Set wire feed speed (amperage control) to desired setting.

NOTE: Arc voltage and amps should be fine tuned while or after running ahead on scrap metal.

C. Set up gun.

1. Conduit and liners that transport wire to gun should be correct size as well as clean and free of obstructions.

   NOTE: Do not use solvents to clean nylon liners used for aluminum.

2. Contact tip or tube should be correct size for wire being used and free of grease, dirt or spatter.

3. Nozzle should be of correct size for welding applications and gas flow volumes and free of spatter.

   NOTE: Some form of anti-spatter compound, either spray can or paste, should be applied to nozzle and contact tip before welding to help prevent spatter build up.

4. Adjust and maintain correct stick out. (Figure 2, next page)

   a. Short arc -- ¼" - 3/8"

JOB SHEET #1

b. Spray arc - 3/4" - 1"

c. Flux cored - ¼" - 2½"

NOTE: In this unit, stick out shall refer to the tip-to-work distance.

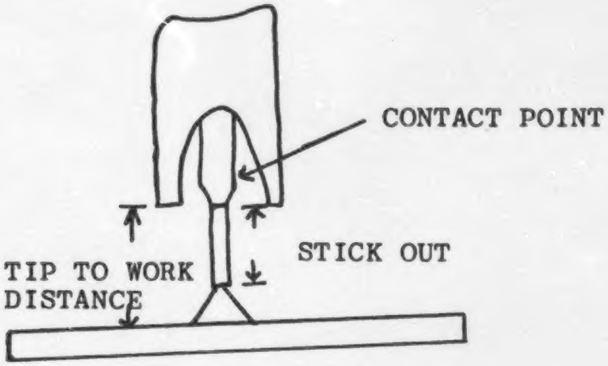


FIGURE 2

III. Shut down procedure.

A. Turn off wire feed speed control.

1. Set control to zero

2. Move wire feed control switch to off after bleeding gas lines.

B. Shut off shielding gas system (if used).

1. Close cylinder valve.

2. Depress welding gun trigger until ball in flowmeter zeros.

3. Close flowmeter adjusting valve finger tight.

C. Turn off welding power supply.

D. Store gun and cable assembly in correct place.

GAS METAL ARC WELDING

JOB SHEET #2 - RUNNING PRACTICE BEADS ON FLAT METAL

I. Equipment and materials needed:

A. Gas metal arc welder

B. CO_2 shielding gas

C. .035 diameter filler wire

D. Current setting 140-160 amp

E. Voltage setting 19-21 arc volts

F. Material-scrap piece of thin metal

G. Face shield, gloves, cape sleeves and apron

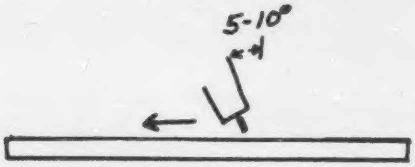
II. Procedure:

A. Adjust power supply and wire feed.

B. Set shielding gas rate of flow to 20 C.F.H.

C. Hold gun as shown in following diagram.

D. Tilt gun at a 5 to 10° angle in direction of travel.



E. Run a number of beads for smoothness and proper contour.

F. Turn work in to instructor for grade.

GAS METAL ARC WELDING

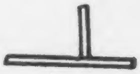
JOB SHEET #3 - CONSTRUCT A SINGLE PASS T-JOINT FILLET WELD IN THE HORIZONTAL POSITION

I. Equipment and materials needed:

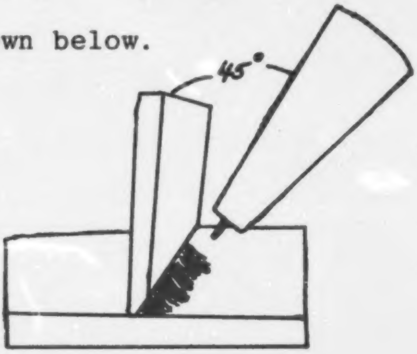
- A. Gas metal arc welder
- B. CO_2 shielding gas
- C. .035 diameter filler wire
- D. 140-160 amp current setting
- E. 19-21 volts
- F. Material - two pieces of 3/16" X 3" X 6" mild steel
- G. Face shield, gloves, cape sleeves and apron

II. Procedure:

- A. Adjust machine as shown above.
- B. Adjust flow of CO_2 to 20 C.F.H.
- C. Position plates as shown below.



- D. Maintain stick out of 1/4" to 3/8".
- E. Hold gun as shown below.



- F. Tack weld upright piece.
- G. Slope metal slightly so weld will be made slightly downhill.
- H. Position gun at 45° angle to upright piece and slanted 5 to 10° in direction of travel.

JOB SHEET #3

I. Start arc weld 1" from end and move quickly to end of joint and begin weld.(This is to help prevent cold lapping)

J. Run one bead on each side of metal.

K. Check beads to see the same amount of weld is on each piece of metal welded.

L. Turn in to instructor for evaluation.

GAS METAL ARC WELDING

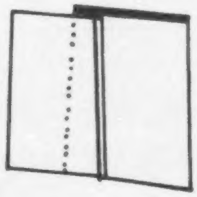
JOB SHEET #4 - LAP JOINT IN VERTICAL DOWN POSITION

I. Equipment and materials needed:

- A. Gas metal arc welder
- B. Carbon dioxide shielding gas
- C. .035 diameter electrode filler wire
- D. 140-160 amp current setting
- E. 19-21 voltage setting
- F. 2 pieces of ¼" mild steel 3" X 6"
- G. Gloves, face shield, cape sleeves and apron

II. Procedure:

- A. Adjust power supply.
- B. Set gas rate at 20 C.F.H.
- C. Lap metal approximately 1" and tack weld.
- D. Position plates in such a manner as to allow weld to be made in a vertical down position. (A position to allow weld to be made at eye level would be desirable.)



- E. Hold gun at a 45° angle to metal and sloped 5 to 10° in direction of travel.
- F. Begin arc 1" from end of desired weld moving quickly to starting point. (This is to prevent cold lapping.)
- G. Maintain stick out of 1/4" to 3/8".

JOB SHEET #4

H. Weld both sides of lap joint.

I. Turn in to instructor for evaluation.

GAS METAL ARC WELDING

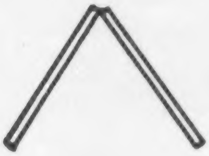
JOB SHEET #5 - CORNER WELD IN FLAT POSITION

I. Equipment needed:

- A. Gas metal arc welder
- B. CO_2 shielding gas
- C. .035 diameter filler wire
- D. 110 to 120 amp current setting
- E. 16 to 19 voltage setting
- F. Material - 2 pieces 3/16" X 3" X 6" mild plate
- G. Gloves, face shield, cape sleeves and apron

II. Procedure:

- A. Adjust power supply.
- B. Set flow of gas at 20 C.F.H.
- C. Set up metal as shown in diagram below.



- D. Hold gun directly above joint to be welded and sloped 5 to 10° in direction of travel.
- E. Begin arc 1" from end of metal, moving quickly to edge to begin weld.
- F. Weld across joint with a slight weaving motion to weld securely both pieces.
- G. Check finished weld to see that weld has been penetrated to the root of the joint and that it has a slightly curved top surface.
- H. Turn finished weld in to instructor for grade.

AMW - 107-B

GAS METAL ARC WELDING

TEST

I. Match the terms below to the correct definition.

___A. Refers to the shape of the volt-ampere curve.

___B. The distance of the contact tip of the gun to the end of the electrode.

___C. Metal transfers across the arc in large droplets at the rate of 100 droplets per second or less.

___D. Short lengths of wire that penetrates through root gap of weld.

___E. Gases used to displace air around weld while in progress to prevent contamination of weld.

___F. Metal transfers across the arc as a fine spray of several hundred droplets per second.

1. Spray Arc
2. Shielding Gases
3. Whiskers
4. Slope
5. Stick Out
6. Short Circuit Method of Transfer

II. List five advantages of gas metal arc welding.

A.

B.

C.

D.

E.

III. Name three types of metal transfer.

A.

B.

C.

IV. List six pieces of equipment needed for gas metal arc welding.

A.

B.

C.

D.

E.

F.

V. Name five types of shielding gases.

A.

B.

C.

D.

E.

VI. Choose from the list below, factors involved in selecting filler wires by placing an "X" in the blank.

___A. Cost

___B. Metal to be welded

___C. Metal surface condition

___D. Position weld is to be made in

VII. Name two types of welding wire.

A.

B.

VIII. Name five types of metal that can be welded with gas metal arc welder.

A.

B.

C.

D.

E.

IX. Name the four welding positions which a gas metal arc welder can be used in.

A.

B.

C.

D.

X. Choose from the list below, common mistakes made in welding by placing an "X" in the correct blank.

___A. Hot Lapping

___B. Cold Lapping

___C. Whiskers

___D. Poor appearance

___E. Poor Penetration

___F. Excessive Penetration

XI. List the three steps in starting a bead with the gas metel arc welder.

A.

B.

C.

XII. List the two types of power sources.

A.

B.

XIII. List four effects of inert gases on weld.

A.

B.

C.

D.

GAS METAL ARC WELDER

ANSWERS TO TEST

I. A. 4

B. 5

C. 6

D. 3

E. 2

F. 1

II. Any five of the following:

A. Arc visible to welder

B. No slag

C. High disposition rate

D. Weld metal of low hydrogen quality

E. Greatly reduced distortion of gage metal

F. Can be used to weld most metals

G. Wide range of metal thickness can be welded without changing wire size.

III. A. Spray

B. Globular

C. Short Circuiting

IV. Any six of the following:

A. Booth

B. Bench

C. Ventilation System

D. Combination gas, water, wire and cable control wire to the gun.

E. Inert gas cylinder

F. Cylinder regulator and flowmeter

- G. Special electrode holder
- H. Remote current control
- I. Electrode wire feed unit
- J. Reel of electrode wire

V. Any five of the following:

- A. Argon
- B. Helium
- C. Carbon Dioxide
- D. Argon-oxygen
- E. Argon-helium
- F. Argon-carbon dioxide
- G. Argon-helium-carbon dioxide

VI. An "X" should be in blanks B. and C.

VII. A. Solid wire

- B. Flux cored wire

VIII. Any five of the following:

- A. Mild steel
- B. Stainless steel
- C. Aluminum
- D. Magnesium
- E. Alloy steels
- F. Copper alloys

IX. A. Flat

- B. Horizontal
- C. Vertical
- D. Overhead

X. An "X" should be in blanks B,C,D,E and F.

XI. A. Touch electrode end to the proper place on metal with helmet up.

B. Lower helmet

C. Press start button on torch

XII. A. Motor generator

B. Transformer-rectifier

XIII. A. Influence shape of weld

B. Determine amount of current needed

C. Amount of spatter

D. Amount of penetration

SHEET METAL

UNIT I

SECTION C

SHEET METAL

TERMINAL OBJECTIVE

After completion of this unit, the student should have a general knowledge of sheet metal. This is to be evidenced by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

I. Match terms associated with sheet metal to the correct definition.

II. Choose from a list, five common uses of sheet metal.

III. Name the two gauges used to measure sheet metal.

IV. Name four common metals formed into sheets.

V. Describe the two types of solder.

VI. List three methods of joining sheet metal together.

VII. Name four instruments which can be used to cut sheet metal.

VIII. List the three types of hammers used in sheet metal work.

IX. List five safety factors in working with sheet metal.

SHEET METAL

SUGGESTED ACTIVITIES

I. Instructor:

  A. Provide student with objective sheet.

  B. Provide student with information sheet.

  C. Discuss terminal and specific objectives.

  D. Discuss information sheets.

  E. Give test.

II. Student:

  A. Read objective sheet.

  B. Study information sheet.

  C. Take test.

INSTRUCTIONAL MATERIAL

I. Included in this unit:

  A. Objective sheets

  B. Information sheets

  C. Test

  D. Answers to test

II. References:

  A. Jones, M.M., Shop Work On The Farm, New York, New York, McGraw Hill Book Co.

  B. Phipps, Lloyd J., Mechanics In Agriculture, Danville, Illinois, The Interstate Printers and Publishers.

  C. Feirer, John L. and Lindbeck, John R., Metalwork, Peoria, Illinois, Charles A. Bennett Co., Inc.

  D. Wakeman, T.J. and McCoy, Vernon Lee, The Farm Shop, New York, New York, The MacMillan Co.

SHEET METAL

INFORMATION SHEET

I. Terms and definitions:

   A. SHEET METAL - Metal ¼" or less in thickness.

   B. PLATE METAL - Metal over ¼" thick.

   C. SHEET METAL GAUGE - Gauge used for determining the thickness of sheet metal.

   D. SHEAR - A tool for cutting metal and other material by the action of two sharp, closely adjoining edges.

   E. SOLDERING - Process of joining two pieces of metal together by a third metal called solder.

   F. AWL - Device for marking sheet metal.

II. Common uses of sheet metal.

   A. Roofing

   B. Parts of machinery

   C. Trailer and truck beds

   D. Utensils, pails, pots and pans

   E. Grain elevators

   F. Safety guards

   G. Car, truck and tractor bodies

   H. Grain bins

   I. Water tanks

   J. Metal furniture

   K. Guttering and flashing

III. Two gauges used to measure sheet metal.

   A. U.S. Standard Gauge

   B. American Standard Wire Gauge

INFORMATION SHEET

IV. Most common metals formed into sheets.

- A. Iron
- B. Steel
- C. Copper
- D. Brass
- E. Zinc
- F. Aluminum

V. Two types of solder.

- A. Soft solder - Melts below a red heat.
- B. Hard solder - Melts above a red heat.

VI. Methods of joining sheet metal together.

- A. Hook joints
- B. Screws
- C. Rivets
- D. By welding
- E. By soldering

VII. Instruments which can be used to cut sheet metal.

- A. Hacksaw
- B. Cold chisel
- C. Metal snips
- D. Double cutting shear
- E. Bench shear

VIII. Three types of hammers used in sheet metal work.

- A. Setting hammer
- B. Riveting hammer
- C. Mallet

INFORMATION SHEET

IX. Safety factors in working with sheet metal.

A. Handle soldering coppers carefully to prevent burns and fires.

B. Keep a foam type fire extinguisher near soldering area if gasoline type blowtorch is used.

C. Never stand on a wet floor while using electric soldering copper.

D. Always inspect the attachment cord of an electric soldering copper for poor insulation before using it.

E. Store soldering coppers in fire proof cabinet and allow coppers to cool before storing.

F. Handle sheet metal carefully to prevent cuts.

G. Eliminate sliver edges when cutting in.

H. Place tin scraps in a special container.

I. Keep work area clean and neat.

J. Wear safety goggles when grinding, filing, drilling or welding sheet metal.

SHEET METAL

TEST

I. Match the terms below to the correct definition.

___1. Metal ¼" or less in thickness.

___2. Tool for cutting metal and other material by the action of two sharp, closely adjoinin edges.

___3. Device for marking sheet metal.

___4. Gauge used for determining the thickness of sheet metal.

___5. Sheets of metal over ¼" thick.

A. Plate Metal

B. Awl

C. Sheet Metal

D. Sheet Metal Gauge

E. Shear

II. Choose from the following list, five common uses of sheet metal, by placing an "X" in the correct blank.

___A. Fencing

___B. Roofing

___C. Parts of Machinery

___D. Trailer & Truck Beds

___E. Grain Elevators

___F. Fence Posts

___G. Water Tanks

III. Name the two gauges used to measure sheet metal.

A.

B.

IV. Name four common metals formed into sheets.

A.

B.

C.

D.

V. Describe the two types of solder.

A.

B.

VI. List three methods of joining sheet metals together.

A.

B.

C.

VII. Name four instruments which can be used to cut sheet metal.

A.

B.

C.

D.

VIII. List the three types of hammers used in sheet metal work.

A.

B.

C.

IX. List five safety factors in working with sheet metal.

A.

B.

C.

D.

E.

SHEET METAL

ANSWERS TO TEST

I. 1. C

2. E

3. B

4. D

5. A

II. An "X" should be in blanks B,C,D,E and G.

III. A. U.S. Standard Gauge

B. American Standard Wire Gauge

IV. Any four of the following:

A. Iron

B. Steel

C. Copper

D. Brass

E. Zinc

F. Aluminum

V. A. Soft solder - Melts below a red heat.

B. Hard solder - Melts above a red heat.

VI. A. Hook joints

B. Screws

C. Rivets

D. By welding

E. By soldering

VII. Any four of the following:

A. Hacksaw

- B. Cold chisel
- C. Metal snips
- D. Double cutting shear
- E. Bench shear

VIII.
- A. Setting hammer
- B. Riveting hammer
- C. Mallet

IX. Any five of the following:

- A. Handle soldering coppers carefully to prevent burns and fires.
- B. Keep a foam type fire extinguisher near soldering area if gasoline type blowtorch is used.
- C. Never stand on a wet floor while using electric soldering copper.
- D. Always inspect the attachment cord of an electric soldering copper for poor insulation before using.
- E. Store soldering coppers in fire proof cabinet and allow coppers to cool before storing.
- F. Handle sheet metal carefully to prevent cuts.
- G. Eliminate sliver edges when cutting in.
- H. Place tin scraps in a special container.
- I. Keep work area clean and neat.
- J. Wear safety goggles when grinding, filing, drilling or welding sheet metal.

SHEET METAL LAYOUT AND CUTTING

UNIT II

SECTION C

SHEET METAL LAYOUT AND CUTTING

TERMINAL OBJECTIVE

After completion of this unit, the student should have a basic knowledge of sheet metal layout and cutting as demonstrated by scoring at least eighty-five percent on the unit test and completing job sheets.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

I. Match terms associated with sheet metal layout and cutting to the correct definition.

II. List four tools used in sheet metal layout.

III. Describe the two tools used to layout lines on sheet metal.

IV. Describe the use of the prick punch and the center punch.

V. Give three uses of dividers.

VI. Choose from a list, five instruments which can be used to cut sheet metal.

VII. Give the uses of the four types of tin snips.

VIII. Name the three types of transfer fluids.

IX. Give the two uses of a combination square in sheet metal work.

X. Name the three gauges used to measure sheet metal.

XI. List the four basic methods of pattern development.

XII. Demonstrate the ability to:

   A. Layout a rectangular object.

   B. Cut sheet metal.

   C. Layout and cut a cone shaped object.

   D. Layout a cylinder.

SHEET METAL LAYOUT AND CUTTING

SUGGESTED ACTIVITIES

I. Instructor:

- A. Provide students with objective sheet.
- B. Provide students with information and job sheets.
- C. Make transparencies.
- D. Discuss terminal and specific objectives.
- E. Discuss information sheets.
- F. Demonstrate and discuss procedures on job sheets.
- G. Give test.

II. Student:

- A. Read objectives.
- B. Study information sheets.
- C. Demonstrate the ability to accomplish the procedures outlined in the job sheets.
- D. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

- A. Objectives
- B. Information sheets
- C. Transparency masters
    1. TM 1 - Sheet Metal Layout Tools
    2. TM 2 - Tools Used To Cut Sheet Metal
- D. Job sheets
    1. Job sheet #1 - Laying Out Rectangular Object
    2. Job sheet #2 - Cutting Sheet Metal

3. Job sheet #3 - Laying Out and Cutting A Cone Shaped Object

4. Job sheet #4 - Laying Out A Cylinder

E. Test

F. Answers to test

II. References:

A. Jones, M.M., Shop Work On The Farm, New York, New York, McGraw Hill Book Co.

B. Wakeman, T.J. and McCoy, Vernon Lee, The Farm Shop, New York, New York, The MacMillan Co.

C. Phipps, Lloyd J., Mechanics In Agriculture, Danville, Illinois, Interstate Printers and Publishers Inc.

SHEET METAL LAYOUT AND CUTTING

INFORMATION SHEET

I. Terms and definitions:

   A. SEAM - Joint used for joining two pieces of metal together.

   B. STOCK - Kind of material used for a project.

   C. TRANSFER FLUID - Solution used to cover metal so that scribed pencil marks show plainly.

   D. CIRCUMFERENCE - Distance around a cylinder.

   E. DIAMETER - Distance through the middle of a cylinder.

   F. PRICK PUNCH - Small punch used to locate the center of scribed surfaces.

   G. PIERCING - Process of cutting metal from the inside of a design with a jewelers saw.

II. Tools used in sheet metal layout.

   A. Metal rule

      1. Up to 5' in length

      2. Marked off in inches and fractions.

         a. Halves

         b. Quarters

         c. Eighths

         d. Sixteenths

         e. Thrity-seconds

         f. Sixty-fourths

   B. Circumference rule

      1. One edge of rule marked in inches.

      2. One edge of rule shows circumference in inches.

INFORMATION SHEET

3. Can be used to determine circumference by measuring the diameter of a cylinder.

C. Steel tape

D. Folding metal rule

E. Folding wooden rule

III. Two tools used to layout lines on sheet metal.

A. Scriber - Used to scratch lines and measurements on hard metals such as tin and iron.

B. Lead pencil - Used for marking bend lines, points to drill and forming lines on soft metals such as copper and aluminum.

IV. Types of punches used in sheet metal work.

A. Prick punch - Used in layout work to locate the center of scribed surfaces.

B. Center punch - Used to enlarge prick punch holes when they are to be drilled.

V. Three uses of dividers.

A. For measuring between points.

B. For transferring measurements directly from a rule.

C. For scribing arcs.

VI. Instruments which can be used to cut sheet metal.

A. Tin snips

B. Hand shears

C. Squaring shears or bench shears

D. Jewelers saws

E. Jig saws

F. Hand punch

INFORMATION SHEET

VII. Four types of tin snips and their uses.

A. Straight snips - Used for cutting straight lines and outside circles.

B. Hawk bill snips - Used for circular cutting in tight places particularly for cutting inside circles.

C. Aviation snips - Used for cutting aluminum and other sheet metals. Some are designed for cutting to the left, some to the right and some are used for cutting straight lines.

D. Circular snips - Used for cutting out intricate patterns and curves. They cut smoothly and leave the metal unbent.

VIII. The three types of transfer fluids and their uses.

A. Layout ink - Purple or blue dye mixed with alcohol or some other thinner. When brushed on metal it dries to a deep blue color on which scratch lines stand out sharply.

B. Show cord white - Used on light metals such as aluminum and pewter. It leaves a dull white surface on which pencil marks show plainly.

C. Zinc chromate primer - Used to prevent corrosion of aluminum. This material serves as a fine layout fluid on aluminum, galvanized metal and sheet iron.

IX. Two uses of a combination square in sheet metal work.

A. Used for marking 90° angles on sheet metal.

B. Used for marking 45° angles on sheet metal.

X. Three gauges used to measure sheet metal.

A. United States Standard Gauge - Used to measure galvanized sheets and black iron.

B. Browne and Sharpe - Used for measuring non-ferrous metals such as aluminum and nickel-silver.

C. American Wire Gauge - Used for maesuring non-ferrous metal and mild steel wire.

INFORMATION SHEET

XI. Four basic methods of pattern development.

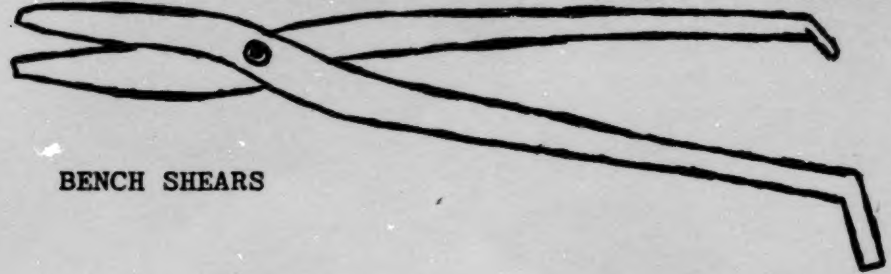
A. Angular - Used for making boxes.

B. Cylindrical - For cylinders.

C. Conical - For cones.

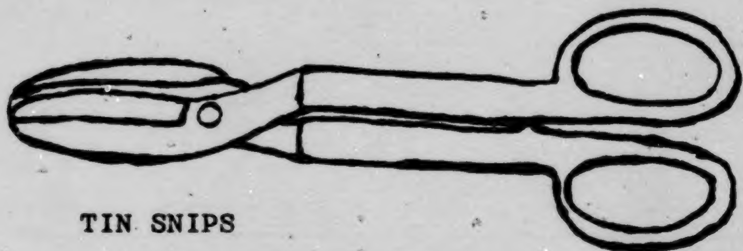
D. Transitional pieces - For pieces which have a different shape at each end.

TOOLS USED TO CUT METAL

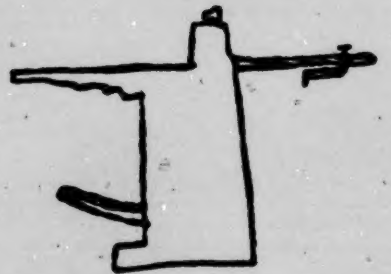


BENCH SHEARS

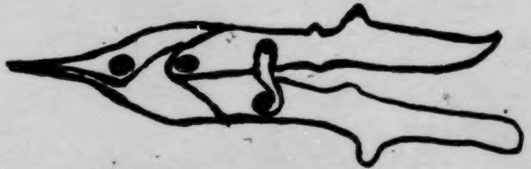
COLD CHISEL



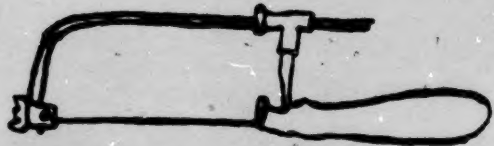
TIN SNIPS



SQUARING SHEAR

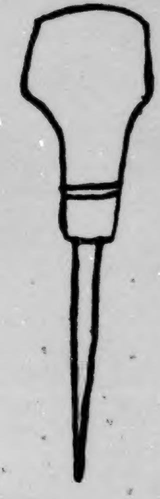


AVIATION SNIPS



JEWELERS SAW

TOOLS USED TO MARK SHEET METAL



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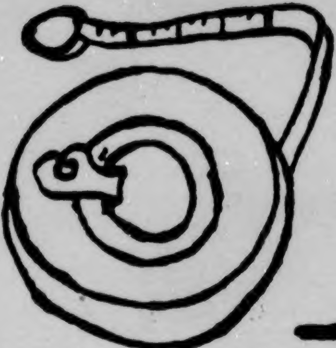
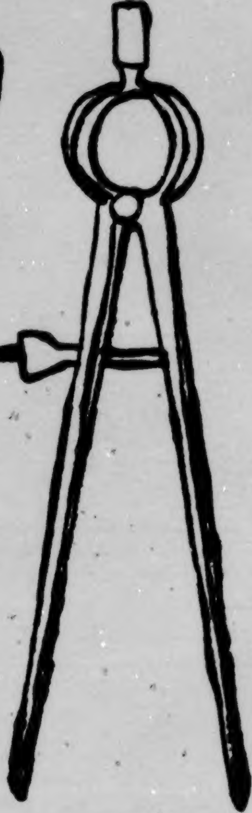
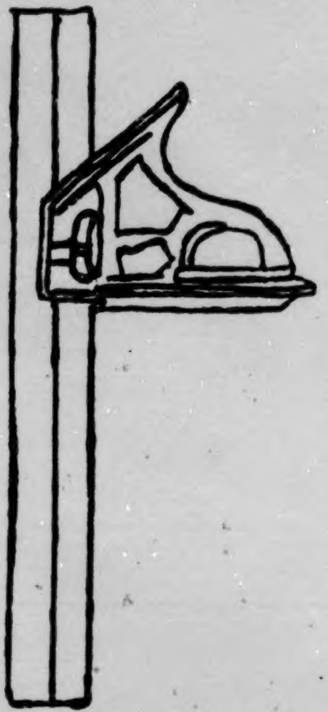


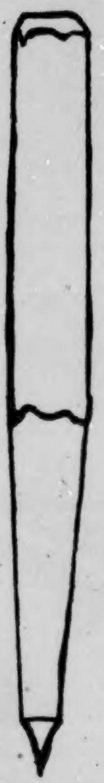
TAPE MEASURE



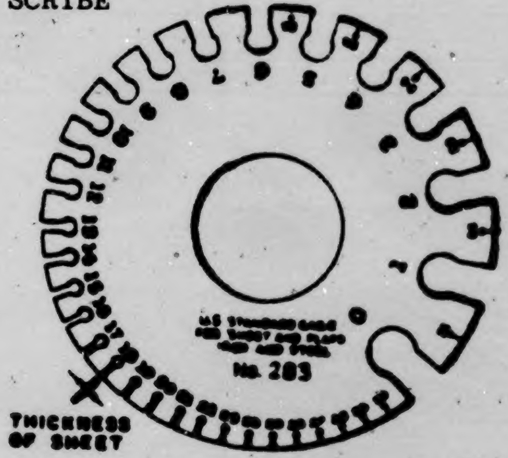
DIVIDERS



COMBINATION SQUARE



PRICK PUNCH


U.S. STANDARD GAUGE FOR SHEET AND PLATE IRON AND STEEL
No. 283
THICKNESS OF SHEET

U.S. STANDARD GAUGE

SHEET METAL LAYOUT AND CUTTING

JOB SHEET #1 - LAYING OUT RECTANGULAR OBJECT

I. Tools and materials needed:

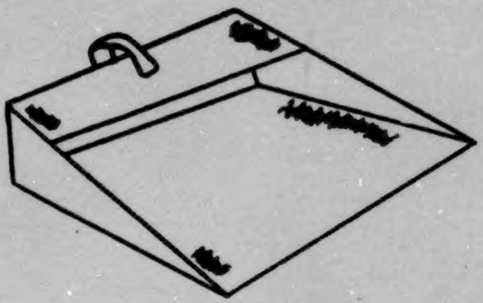
- A. Framing square
- B. Scratch awl
- C. Tri-square
- D. 28 gauge galvanized metal 12" X 15"
- E. Straight cutting tin snips

II. Procedure:

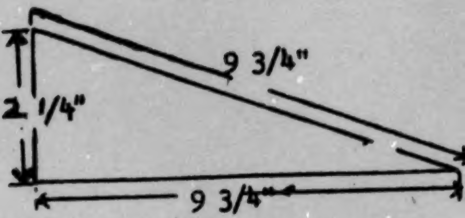
- A. With framing square and scratch awl, square one corner of metal.
- B. Cut away any metal necessary.
- C. Layout and cut rectangle 11½" X 14".
- D. With square and awl, draw all interior lines as shown on the diagram to follow.

(This metal should be kept, as it will be used on next job sheet)

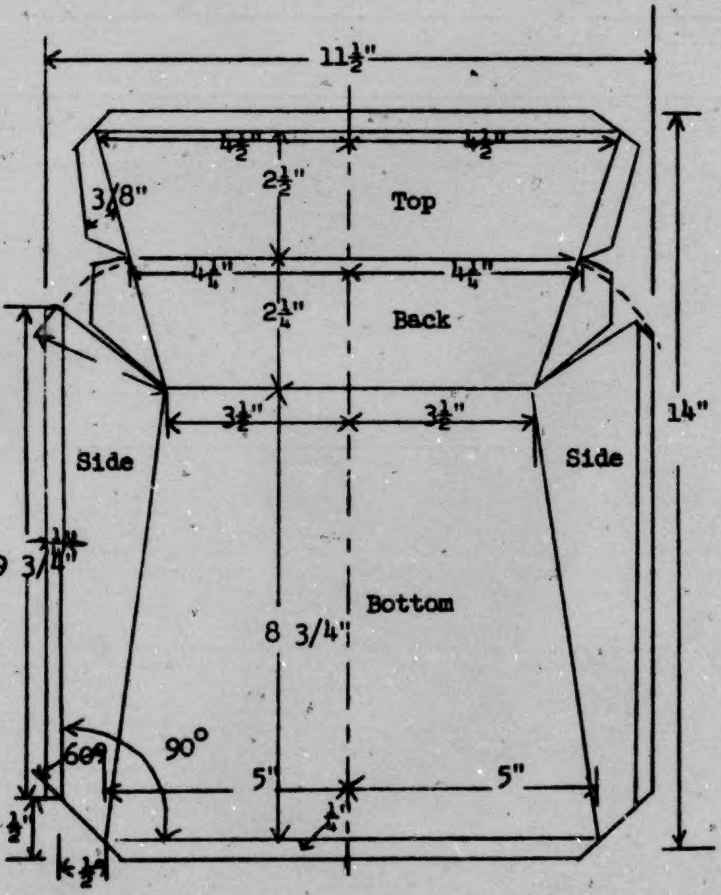
DUST PAN



Finished



Side View


11½"
4½"
4½"
2½"
3/8"
Top
4¼"
4¼"
2¼"
Back
3½"
3½"
Side
Side
14"
9 3/4"
¼"
Bottom
8 3/4"
60°
90°
5"
5"
¼"
½"
½"

Top View

FIGURE 2 217

SHEET METAL LAYOUT AND CUTTING

JOB SHEET #2 - CUTTING SHEET METAL

I. Tools and materials needed:

   A. Straight cut tin snips

   B. File

   C. Metal drawn out in job sheet #1

   D. Circle cutting tin snips or hawk bill snips

   E. Dividers

   F. 28 gauge metal 5" X 5"

   G. Metal rule

   H. Prick punch

   I. Hammer

II. Procedure:

   A. Cutting dust pan

      1. Cut lines as shown on diagram of dust pan to start.

      2. Hold tin snips with jaws open as wide as it is comfortable to hold snips.

      3. Keep the blade at a right angle and cut the sheet by closing the blades on line as the cut is made.

      4. Remove any sharp or rough edges with a flat file.

   B. Cut 4" circle from sheet metal.

      1. Take one piece of 28 gauge metal 5" X 5".

      2. Punch hole in center of plate using prick punch, metal rule and hammer.

      3. With dividers and metal rule, draw a 4" diameter circle.

JOB SHEET #2

4. Cut excess metal away at corners of metal.
5. With circular cutting snips, cut around line drawn with dividers.
6. Turn the dust pan and circular pieces of metal in to instructor for grade.

(Dust pan should be kept for use in later unit.)

SHEET METAL LAYOUT AND CUTTING

JOB SHEET #3 - LAYING OUT AND CUTTING A CONE SHAPED OBJECT

I. Tools and equipment needed:

A. Compass

B. Poster board

C. Dividers

D. Scissors

E. Circle cutting tip snips

F. 28 gauge sheet metal

G. Straight edge of tri-square

H. Ruler

II. Procedure:

A. On sheet of poster board, draw front view of cone shaped object B,C,E and D. (See diagram)

B. Draw semicircle B C.

C. Divide this semicircle into an even number of equal parts.

D. Number these divisions.

E. Draw arc BG with radius A B.

F. Using same center, draw arc D F with radius A D.

G. On arc B G, mark off twice the number of equal divisions found on the semicircle.

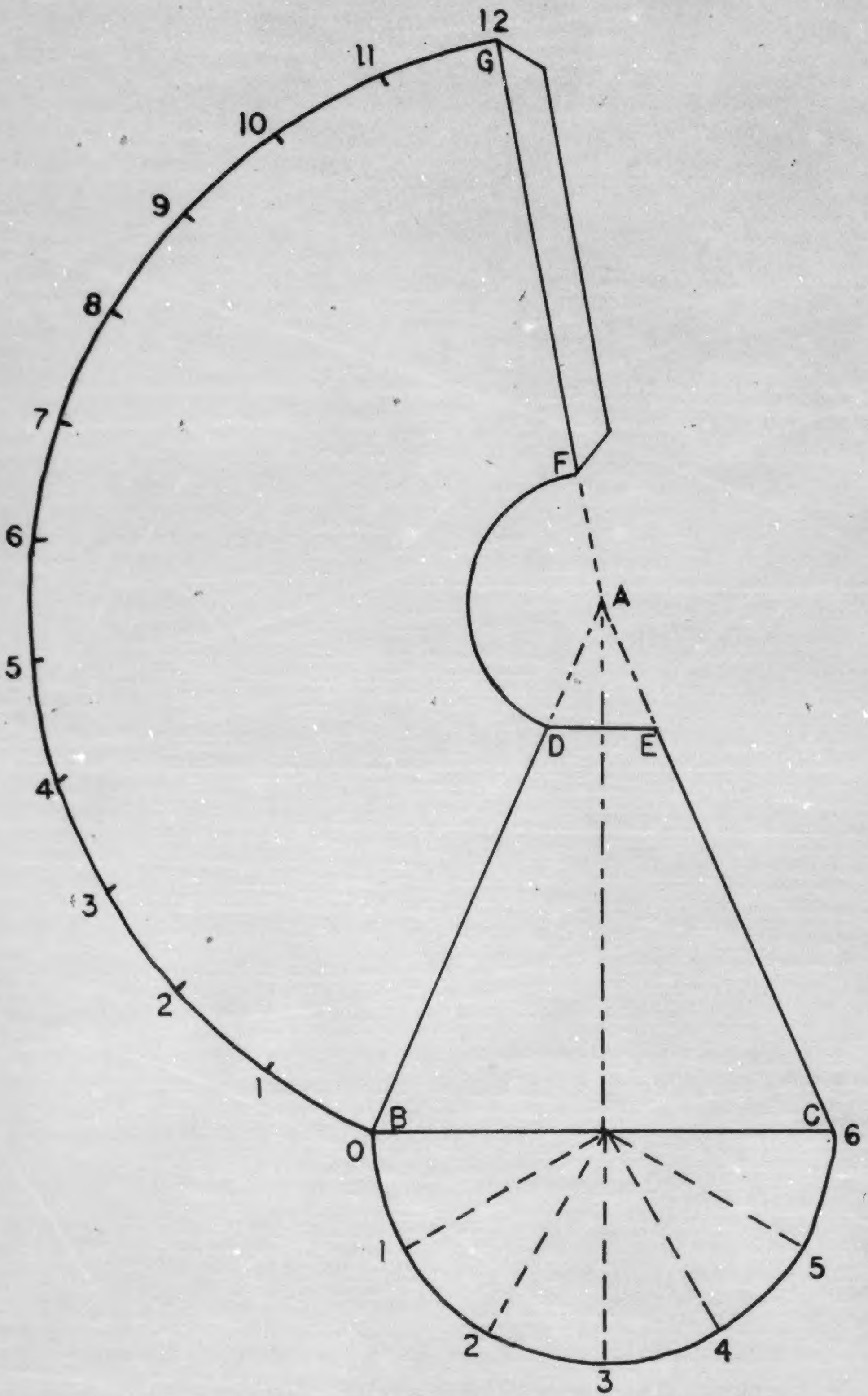
H. Draw a line from the last division point to "A" to form the layout d,b,g and f.

I. Add ¼" for seam.

J. With scissors, cut out pattern d,b,f,g with ¼" added for seam.

K. Transfer this pattern to the sheet metal.

L. Cut out pattern with circle cutting tin snips.


G
F
A
D
E
B
C

SHEET METAL LAYOUT AND CUTTING

JOB SHEET #4 - LAYING OUT A CYLINDER

I. Tools and materials needed:

   A. Framing square

   B. Scratch awl

   C. Tie square

   D. Straight cutting tin snips

   E. 28 gauge sheet metal approximately 6½" X 12½"

II. Procedure:

   A. A cylinder layed out forms a rectangle.

   B. Layout a rectangle 6" X 12".

   C. Cut away excess metal with tin snips.

   D. Draw a line ¼" from each end along 6" side.

   E. Check corners for squareness.

   F. Work on this piece until all sides are square.

   G. Correct size is obtained.

   H. Turn in to instructor for grade.

   (Save metal for later exercise)

SHEET METAL LAYOUT AND CUTTING

TEST

I. Match the terms below to the correct definition.

___1. Joint used for joining two pieces of metal together.

___2. Distance around a cylinder.

___3. Process of cutting metal from the inside of a design with a jewelers saw.

___4. Kind of metal used for a project.

___5. Small punch used to locate the center of scribed surfaces.

A. Piercing
B. Prick Punch
C. Stock
D. Seam
E. Circumference

II. List four tools used in sheet metal layout.

A.

B.

C.

D.

III. Describe the two tools used to layout lines on sheet metal.

A. Scriber -

B. Lead Pencil -

IV. Describe the use of the prick punch and the center punch.

A. Prick punch -

B. Center punch -

V. Give three uses of dividers.

A.

B.

C.

VI. Choose form the following list, five instruments which can be used to cut sheet metal by placing an "X" in the correct blank.

___A. Tin snips

___B. Jig Saw

___C. Bench Break

___D. Squaring Shear

___E. Jewelers Saw

___F. Center Punch

___G. Bench Shear

___H. File

VII. Give the uses of the following four types of tin snips.

A. Straight snips -

B. Hawk Bill snips -

C. Aviation snips -

D. Circular snips -

VIII. Name three types of transfer fluids.

A.

B.

C.

IX. Give the two uses of a combination square in sheet metal work.

A.

B.

X. Name the three gauges used to measure sheet metal.

A.

B.

C.

XI. List the four basic methods of pattern development.

A.

B.

C.

D.

C. Aviation snips - Used for cutting aluminum and other sheet metals. Some are designed for cutting to the left, some to the right and some are used for cutting straight lines.

D. Circular snips - Used for cutting out intricate patterns and curves. They cut smoothly and leave the metal unbent.

VIII. A. Layout ink

B. Show cord white

C. Zinc chromate primer

IX. A. Used for marking 90° angles on sheet metal.

B. Used for marking 45° angles on sheet metal.

X. A. U.S. Standard Gauge

B. Browne and Sharpe

C. American Wire Gauge

XI. A. Angular

B. Cylindrical

C. Conical

D. Transitional pieces

BENDING AND JOINING SHEET METAL

UNIT III

SECTION C

BENDING AND JOINING SHEET METAL

TERMINAL OBJECTIVE

After completion of this unit, the student should be able to bend and join sheet metal together. This is to be evidenced by demonstration and by scoring at least eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

I. Match terms associated with bending and joining sheet metal to the correct definition.

II. List four devices used to bend sheet metal.

III. Describe the uses of the different stakes used with bench plate.

IV. List the four step procedure for making a simple bend.

V. Describe the use of a hand seamer.

VI. Choose from a list, four methods of fastening sheet metal together.

VII. Arrange in order, the steps to follow in making a ¼" grooved seam in a cylinder.

VIII. List the steps used in joining sheet metal with screws.

IX. Choose from a list, ways in which rivets vary.

X. List three metals from which rivets are made.

XI. Describe how the size of rivets are determined.

XII. Name the three types of rivet heads.

XIII. Arrange in order, the steps used in riveting sheet metal together.

XIV. List two metals which can be soldered with a solder composed of lead and tin.

XV. Choose from a list, three sources of heat used in soldering.

XVI. List the steps involved in tinning a soldering copper.

XVII. List four things necessary to produce a good job of soldering.

XVIII. List five steps in properly cleaning metal for soldering.

XIX. List two reasons for using flux while soldering.

XX. Describe the proper procedure for applying solder to a joint.

XXI. Demonstrate the ability to:

- A. Bend metal and join with pop rivets.
- B. Join metal with hook joint and soldering.
- C. Joining metal with rivets.

BENDING AND JOINING SHEET METAL

SUGGESTED ACTIVITIES

I. Instructor:

- A. Provide students with objective sheet.
- B. Provide students with information and job sheets.
- C. Make transparencies.
- D. Discuss terminal and specific objectives.
- E. Discuss information sheets.
- F. Demonstrate and discuss procedures outlined in job sheets.
- G. Give test.

II. Student:

- A. Read objectives.
- B. Study information sheet.
- C. Demonstrate the ability to accomplish the procedures outlined in the job sheet.
- D. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

- A. Objectives
- B. Information sheets
- C. Transparency masters
    - 1. TM 1 - Bench Plate and Stakes
    - 2. TM 2 - Types of Rivets
- D. Job sheets
    - 1. Job sheet #1 - Bending Metal and Join With Pop Rivets

2. Job sheet #2 - Joining Metal By Hook Joint and Soldering

3. Job sheet #3 - Joining Metal With Rivets

E. Test

F. Answers to test

II. References:

A. Wakeman, T.J. and McCoy, Vernon Lee, *The Farm Shop*, New York, New York, The MacMillan Co.

B. Phipps, Lloyd J., *Mechanics in Agriculture*, Danville, Illinois, The Interstate Printers and Publishers.

C. Feirer, John L. and Lindbeck, John R., *Metalwork*, Peoria, Illinois, Charles A. Bennett Co., Inc.

D. Jones, Mack M., *Shop Work On The Farm*, New York, New York, McGraw Hill Book Co.

BENDING AND JOINING SHEET METAL

INFORMATION SHEET

I. Terms and definitions:

A. SOFT SOLDER - Solder which melts before red heat.

B. HARD SOLDER - Solder which melts above red heat.

C. SOLDERING - Process of joining metal parts with a filler metal called solder.

D. HEM - Folded edge on sheet metal.

E. SINGLE HEM - Edge of metal folded one time.

F. DOUBLE HEM - Edge of metal folded two times.

G. SEAM - Where two pieces of metal join.

H. FLUX - Material used to prevent the oxidation of metal and to aid in the flow of the solder.

I. TINNING A SOLDERING COPPER - Applying a thin coat of solder to the soldering copper.

J. WIRE HEM - Hem formed by folding edge of metal over a wire.

II. Devices used to bend sheet metal.

A. Bench break

B. Bench plate with stakes

C. Pieces of rod

D. Angle iron

E. Wooden form block

F. Vise

G. Hand Seamer

H. Rectangular bar stock

I. Edge of a work bench

III. Stakes and their uses when used with a sheet metal bench plate.

A. Hatchet stake - Used for making sharp angle bends.

B. Conductor stake - Used for making cylindrical shapes.

C. Blow Horn stake - Used for making conical shapes.

D. Candle mold stake - Used for making small cylinders and cones.

INFORMATION SHEET

IV. Procedure for making a simple bend.

A. Layout the bend line.

B. Hold or clamp metal firmly over the sharp edge of a bench or stake with the bend line flush with the edge of table or stake.

C. Force metal down a little at a time with one hand.

D. To finish a sharp edge, gently strike the metal near the bend line with a wooden mallet.

V. Procedure for use of a hand seamer.

A. Can be used to make bends up to 1" from edge.

B. Use as you would a pair of pliers, squeeze material between the jaws and bend a little at a time as you move seamer along joint.

VI. Methods of fastening sheet metal together.

A. Hook joints

B. Special screws

C. Soldering

D. Welding

E. Riveting

VII. Steps to follow in making a ¼" folded or grooved seam in a cylinder.

A. Allow 5/8" extra metal to form seam.

B. Bend edge on ¼" line in opposite direction.

C. Do not fold edge completely.

D. Hook edges together.

E. Place seam over a solid backing.

F. Close seam by using a wooden or leather mallet.

G. Select hand groover the width of seam.

H. Place groover over seam and strike with hammer until the two edges are flush.

VIII. Steps used in joining sheet metal with screws.

A. Lap metal to be joined.

INFORMATION SHEET

B. With punch or drill, place a small hole through the two plates smaller than screw to be used.

C. The screw will cut threads in metal as it is screwed into the metal.

D. Pull metal together tightly being careful not to strip out hole with screw.

IX. Rivets vary as to the:

A. Kind of metal

B. Kind of head

C. Diameter

D. Length

X. Metals from which rivets are made.

A. Aluminum

B. Copper

C. Brass

D. Mild steel (block iron)

E. Magnesium

XI. The size of rivets are determined by its weight per thousand rivets.

XII. Three types of rivet heads.

A. Flat head

B. Round head

C. Counter sunk

XIII. Steps to follow in riveting sheet metal.

A. Layout location for rivets.

B. Punch or drill holes for rivets.

C. Insert rivets in holes.

D. Place work piece over a solid metal surface.

E. With a rivet set, draw the seams together.

INFORMATION SHEET

F. Strike rivet with hammer with enough force to hold pieces together.

G. Place concave portion of rivet set over the rivet and hit it. (One or two blows is usually enough)

XIV. Metals which can be soldered with a solder composed of lead and tin.

A. Galvanized iron

B. Tin plate

C. Copper

XV. Sources of heat used in soldering.

A. Soldering copper

B. Gas furnace

C. Electric soldering copper

D. Electric soldering gun

E. Propane torch

XVI. Steps involved in tinning a soldering copper.

A. Heat copper to a yellow or light brown color.

B. Clamp the copper in a vise and file the point to a gentle taper, not blunt, being careful to remove any pitted places in copper.

C. Reheat the soldering copper enough to melt solder.

D. Rub clean point on cake of Sal Ammoniac.

E. Add small amounts of solder until tip is covered with thin coat.

XVII. Essentials for a good job of soldering.

A. A clean, hot source of heat.

B. A hot, well tinned soldering iron.

C. Thoroughly cleaned metals to be soldered.

D. A proper, good quality flux.

INFORMATION SHEET

E. Metal heated enough to prevent solder setting too quickly.

F. Solder well sweated into joint.

XVIII. Steps for properly cleaning metal for soldering.

A. Remove grease with a safe liquid solvent.

B. File or grind until clean.

C. Apply muriatic acid.

D. Rub with sandpaper.

E. Wash with water to remove acid.

F. Apply proper flux.

XIX. Reasons for using flux while soldering.

A. Remove oxide film from metal.

B. Prevents oxidation while soldering.

C. Helps the molten solder to spread over surface to be soldered and helps it to adhere.

XX. Procedure for applying solder to a joint.

A. Heat soldering iron and dip in flux.

B. Place small amount of solder on tip of iron.

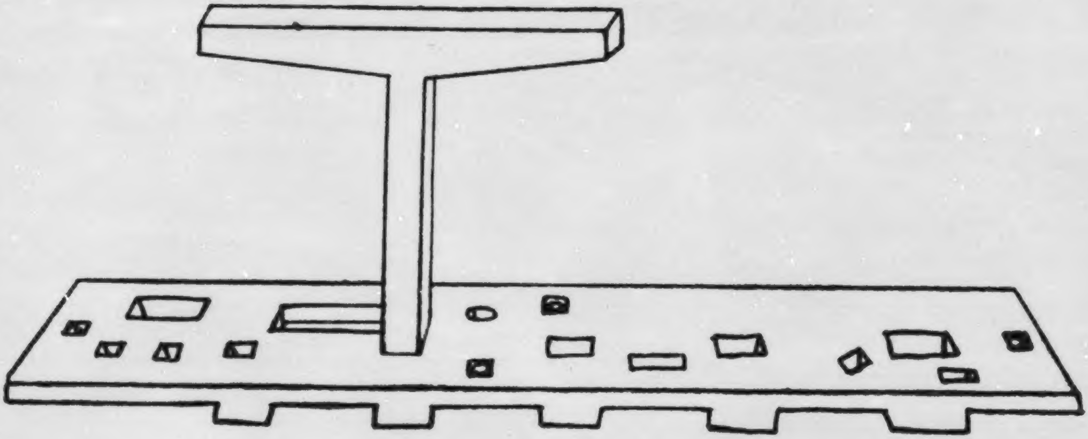
C. Apply tip of iron to metal to be welded.

D. As solder spreads over surface of joint, apply more solder to iron as it is moved along joint.

E. Care should be taken to apply only the amount of solder needed as excessive solder distracts from the appearance of work.

F. Reheat soldering copper as needed.

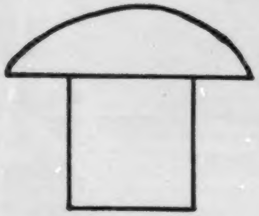
BENCH PLATE AND STAKES



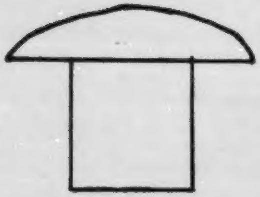
BENCH PLATE for holding stakes.

TYPES OF RIVETS

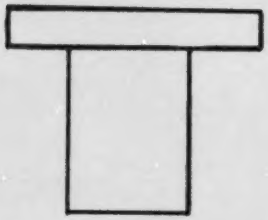
HEAD TYPES



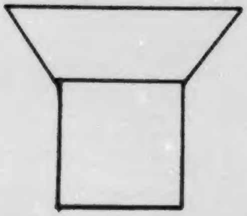
A. ROUND



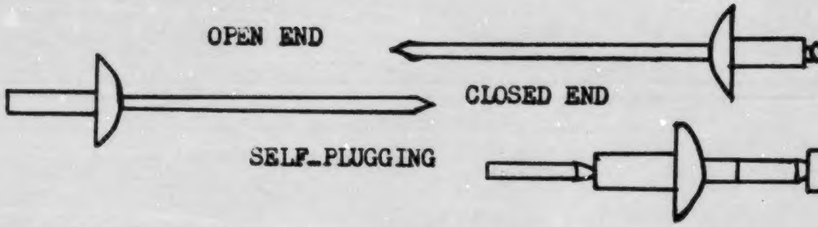
B. OVAL



C. FLAT

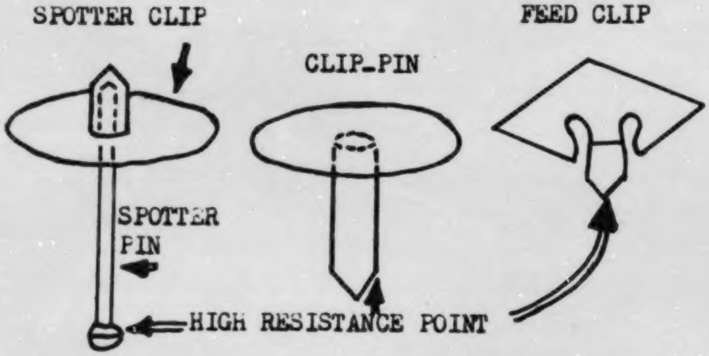


D. COUNTERSUNK


OPEN END
CLOSED END
SELF_PLUGGING

E. BLIND

USES: FASTENING METAL TO NON_METALLIC MATERIAL
MAY BE INSERTED AND SET FROM ONE SIDE


SPOTTER CLIP
CLIP_PIN
FEED CLIP
SPOTTER PIN
HIGH RESISTANCE POINT

F. PINSPOTTER CLIPS

USES: FASTENING SHEET METAL TO NON_METALLIC MATERIAL

BENDING AND JOINING SHEET METAL

JOB SHEET #1 - BENDING OR FORMING A DUST PAN AND JOINING WITH POP RIVETS

I. Tools and materials needed:

  A. Mallet

  B. Vise with two pieces of angle iron or bench break or wooden form block

  C. Hand seamer

  D. Metal for dust pan cut out for job sheet #2 of "Sheet Metal Layout and Cutting".

  E. Pop riveter with 1/8" X 1/8" rivets

  F. Electric drill

  G. 1/8" metal bit

  H. Hammer

  I. Prick punch

  J. Wooden block

II. Procedure:

  A. Fold down edge on ¼" in all around dust pan in one direction by placing metal between jaws of a vise with ¼" line at level with jaws of vise and striking lightly with mallet or by placing metal in a metal break and bending to 90° angle.

  B. Complete this outer seam by placing on flat surface and closing seam with mallet.

  C. Bend sides, back and top at 90° angle using vise or bench break and vise.

  D. Bend connecting flap to 90° angle using hand seamer.

  E. With center punch, mark location for two holes in each connecting flap.

  F. Holding box securely in desired finished position, drill one hole in each flap connecting top of dust pan to the side piece, drill through both pieces.

JOB SHEET #1

G. Place pop rivet in riveter.

H. Place pop rivet in drilled hole.

I. Squeeze the handle until rivet pulls into two pieces.

J. Do opposite sides of dust pan in the same manner.

K. This will hold pan in alignment as other holes are drilled and rivets secured.

L. Turn in finished product for grade.

BENDING AND JOINING SHEET METAL

JOB SHEET #2 - JOINING METAL BY HOOK JOINT AND SOLDERING

I. Tools and materials needed:

- A. Mallet
- B. Vise or bench break
- C. 2' section of 3" pipe
- D. Hammer
- E. 3/8" hand seamer
- F. Soldering iron
- G. Source of heat
- H. Acid core solder
- I. Sandpaper
- J. Clean, damp cloth

II. Procedure:

- A. Secure metal layed out in assignment sheet #4 of unit "Sheet Metal Layout and Cutting".
- B. Bend ¼" line on each end of piece in opposite directions. (Do not hammer down tightly)
- C. Bend metal and hook the ends together.
- D. Place cylinder over pipe clamped securely in vise.
- E. With leather mallet, close joint completely.
- F. Take hand groover, equal to width of seam.
- G. Place groover directly over the seam and strike with a hammer until the two edges are flush.
- H. Move groover along the seam closing it along its entire length.
- I. With sandpaper, clean joint thoroughly.
- J. Heat soldering copper to correct temperature.

JOB SHEET #2

K. Press the soldering copper at one end of the seam until the metal is hot enough to melt the solder.

L. Hold the copper flat against the seam until the solder will flow freely.

M. Apply a little solder beneath the copper and draw copper along the seam.

N. Watch closely to see that solder melts and spreads correctly.

O. Solder entire length of seam.

P. With clean, damp cloth, remove the excess acid from the seam.

Q. The soldered seam should have a smooth shiny surface when soldering job is finished.

R. Turn in to instructor for grade.

BENDING AND JOINING SHEET METAL

JOB SHEET #3 - JOINING SHEET METAL WITH RIVETS

I. Tools and materials needed:

A. Riveting hammer

B. Rivet set

C. Electric drill

D. 1/8" metal bit

E. Center punch

F. 1/8" flat head, tinners rivets

G. 2 pieces of 28 gauge sheet metal 3" X 12"

H. Rule or tape measure

II. Procedure:

A. Overlap pieces one inch along the 12 inch side of metal pieces.

B. Center punch for hole 1" from each end and in the middle of the overlap.

C. Drill the two holes.

D. Place rivet through one set of these holes and place base of rivet on anvil.

E. Draw pieces together using rivet set.

F. Strike the rivet with the hammer to set the rivet enough to hold the pieces together.

G. Place the concave portion of the rivet set over the rivet and hit it. One or two blows is usually enough.

H. Set second rivet in hole at opposite end of piece and go through the same procedure as with first rivets.

I. These rivets will hold metal in place as other rivets are placed.

J. Mark off for rivets 2" apart along the entire length of seam.

JOB SHEET #3

K. Center punch for holes.

L. Drill holes and rivet using same procedure as with first two rivets.

M. Turn in to instructor for grade.

BENDING AND JOINING SHEET METAL

TEST

I. Match the terms below to the correct definition.

___A. Material used to prevent the oxidation of metal and to aid in the flow of the solder.

___B. Process of joining metal parts with a filler metal called solder.

___C. Where two pieces of metal join.

___D. Folded edge of sheet metal.

___E. Solder which melts before red heat.

___F. Solder which melts above red heat.

___G. Applying a thin coat of solder to the soldering copper.

1. Hem
2. Tinning A Copper
3. Seam
4. Soft Solder
5. Flux
6. Soldering
7. Hard Solder

II. List four devices used to bend sheet metal.

A.

B.

C.

D.

III. Describe the use of the following stakes used with a bench plate.

A. Hatchet stake -

B. Conductor stake -

C. Blow horn stake -

D. Candle mold stake -

IV. List the four step procedure for making a simple bend.

A.

B.

C.

D.

V. Describe the use of a hand seamer.

VI. Choose from the following list, four methods of fastening sheet metal together, by placing an "X" in the correct blank.

___A. Lap joint
___B. Hook joint
___C. Laser beam
___D. Soldering
___E. Welding
___F. Rivets

VII. Arrange in order the following steps in making a ¼" grooved or folded seam in a cylinder by placing the correct sequence number in the appropriate blank.

___A. Hook edges together.
___B. Place groover over seam and strike with hammer until the two edges are flush.
___C. Place seam over a solid backing.
___D. Allow 5/8" extra metal to form seam.
___E. Do not fold edge completely.
___F. Select hand groover the width of seam.
___G. Bend edge on ¼" line in opposite direction.
___H. Close seam by using a wooden mallet.

VIII. List the steps used in joining sheet metal with screws.

A.

B.

C.

D.

IX. Choose from the list below, ways in which rivets vary by placing an "X" in the correct blank.

___A. Length
___B. Kind of head
___C. Diameter
___D. Kind of metal

X. List three metals from which rivets are made from.

A.

B.

C.

XI. Describe how the size of rivets are determined.

XII. Name the three types of rivet heads.

A.

B.

C.

XIII. Arrange in order, the steps used in riveting sheet metal together by placing the correct sequence number in the appropriate blank.

___A. Layout location of rivets.

___B. Draw seam together with rivet set.

___C. Strike rivet with enough force to hold together.

___D. Place work piece over a solid metal surface.

___E. Insert rivets in hole.

___F. Punch or drill holes for rivets.

___G. Place concave portion of rivet set over the rivet and hit it.

XIV. List two metals which can be soldered with a solder composed of lead and tin.

A. B.

XV. Choose from a list, three sources of heat used in soldering, by placing an "X" in the correct blank.

___A. Forge ___C. Propane Torch

___B. Gas Furnace ___D. Soldering Copper

XVI. List steps involved in tinning a soldering copper.

A.

B.

C.

D.

E.

XVII. List four things necessary to produce a good job of soldering.

A.

B.

C.

D.

XVIII. List five steps in properly cleaning metal for soldering.

A.

B.

C.

D.

E.

XIX. List two reasons for using flux while soldering.

A.

B.

XX. Describe the proper procedure for applying solder to a joint.

BENDING AND JOINING SHEET METAL

ANSWERS TO TEST

I. A. 5

B. 6

C. 3

D. 1

E. 4

F. 7

G. 2

II. Any four of the following:

A. Bench break

B. Bench plate with stakes

C. Pieces of rod

D. Angle iron

E. Wooden form block

F. Vise

G. Hand seamer

H. Rectangular bar stock

I. Edge of a work bench

III. A. Hatchet stake - Used for making sharp angle bends.

B. Conductor stake - Used for making cylindrical shapes.

C. Blow horn stake - Used for making conical shapes.

D. Candle mold stake - Used for making small cylinders and cones.

IV. A. Layout the bend line.

B. Hold or clamp metal firmly over the sharp edge of a bench or stake with the bend line flush with the edge of table or stake.

C. Force metal down a little at a time with one hand.

D. To finish a sharp edge, gently strike metal near the bend line with a wooden mallet.

V. Should contain the following information.

A. Can be used to make bends up to 1" from edge.

B. Use as you would a pair of pliers, squeeze material between the jaws and bend a little at a time as you move seamer along joint.

VI. An "X" should be in blanks B,D,E and F.

VII. A. 4

B. 8

C. 5

D. 1

E. 3

F. 7

G. 2

H. 6

VIII. A. Lap metal to be joined.

B. With punch or drill, place a small hole through the two plates smaller than screw to be used.

C. The screw will cut threads in metal as it is screwed into the metal.

D. Pull metal together tightly being careful not to strip out hole with screw.

IX. An "X" should be in blanks A,B,C and D.

X. Any three of the following:

A. Aluminum

B. Copper

C. Brass

D. Mild steel (block iron)

E. Magnesium

XI. The size of rivets are determined by its weight per thousand rivets.

XII. A. Flat head B. Round head C. Counter Sunk

XIII. A. 1

B. 5

C. 6

D. 4

E. 3

F. 2

G. 7

XIV. Any two of the following:

A. Galvanized iron

B. Tin plate

C. Copper

XV. An "X" should be in blanks B,C and D.

XVI. A. Heat copper to a yellow or light brown color.

B. Clamp the copper in a vise and file the point to a gentle taper, not blunt, being careful to remove any pitted places in copper.

C. Reheat the soldering copper enough to melt solder.

D. Rub clean point on cake of Sal Ammoniac.

E. Add small amounts of solder until tip is covered with thin coat.

XVII. Any four of the following.

A. A clean, hot source of heat.

B. A hot well tinned soldering iron.

C. Thoroughly cleaned metals to be soldered.

D. A proper, good quality flux.

E. Metal heated enough to prevent solder setting too quickly.

F. Solder well sweated into joint.

XVIII. A. Remove grease with a safe liquid solvent.

B. File or grind until clean.

C. Apply muriatic acid.

D. Rub with sandpaper.

E. Wash with water to remove acid.

F. Apply proper flux.

XIX. Any two of the following:

A. Remove oxide film from metal.

B. Prevents oxidation while soldering.

C. Helps the molten solder to spread over surface to be soldered and helps it to adhere.

XX. A. Heat soldering iron and dip in flux.

B. Place small amount of solder on tip of iron.

C. Apply tip of iron to metal to be welded.

D. As solder spreads over surface of joint, apply more solder to iron as it is moved along joint.

E. Care should be taken to apply only the amount of solder needed as excessive solder distracts from the appearance of work.

F. Reheat soldering copper as needed.

BLUEPRINT READING FOR WELDERS

UNIT I

SECTION D

BLUEPRINT READING FOR WELDERS

TERMINAL OBJECTIVE

After completion of this unit, the student should have a basic knowledge of blueprint reading for welders. This knowledge will be evidenced through demonstration and by scoring at least eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

I. Match terms associated with blueprint reading to the correct definition.

II. Identify the three views of an orthographic drawing.

III. Name the two ways of showing dimensions on a drawing.

IV. Choose from a list, the types of lines used in welding drawings.

V. Identify the two parts of the welding symbol.

VI. Match 6 welding symbols with their name.

VII. Describe the significance of the location of the weld symbol on the reference line.

VIII. List five weld symbol elements that can be added to symbols.

IX. List four methods of attaining weld finishes used on welding symbols.

X. Choose from a list, four pieces of information found in the specification section of drawing.

XI. List the two types of abbreviations used in welding blueprints.

XII. Demonstrate the ability to:

  A. Identify weld symbols

  B. Describe weld symbols

  C. Interpreting General Abbreviations

D. Interpret welding abbreviations

E. Gather information from a blueprint

BLUEPRINT READING FOR WELDERS

SUGGESTED ACTIVITIES

I. Instructor:

- A. Provide student with objective sheet.
- B. Provide student with information and assignment sheets.
- C. Make transparencies.
- D. Discuss terminal and specific objectives.
- E. Discuss information sheets.
- F. Demonstrate and discuss procedures outlined in assignment sheets.
- G. Give test.

II. Student:

- A. Read objectives.
- B. Study information sheet.
- C. Demonstrate the ability to accomplish the procedures outlined in the assignment sheets.
- D. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

- A. Objectives
- B. Information sheets
- C. Transparency masters
    1. TM 1 - Basic Lines
    2. TM 2 - Welding Symbol
    3. TM 3 - Elements Applied To Welding Symbol To Donate Various Welds

4. TM 4 - Additional Welding Symbol Elements
5. TM 5 - General Abbreviations Used In Blueprinting
6. TM 6 - General Abbreviations Used In Blueprinting (Continued)
7. TM 7 - Welding Abbreviations

D. Assignment sheets

1. Assignment sheet #1 - Identification of Weld Symbols
2. Assignment sheet #2 - Describing Weld Symbols
3. Assignment sheet #3 - Interpreting General Abbreviations
4. Assignment sheet #4 - Interpreting Welding Abbreviations
5. Assignment sheet #5 - Gathering Information From A Blueprint

E. Test

F. Answers to test

II. References:

A. Griffin, Ivan H., and Roden, Edward M., Welding Processes, Albany, New York, Delmar Publishers.

B. Olthouse, Turnquist and Bowditch, Modern Welding, Homewood, Illinois, The Goodheart Wilcox Co.

C. Bennett, A.E. and Siy, Louis J., Blueprint Reading for Welders, Albany, New York, Delmar Publishers.

D. Welding Training Manual, Arkansas Industry Training.

BLUEPRINT READING FOR WELDERS

INFORMATION SHEET

I. Terms and definitions:

- A. SYMBOLS - Characters or arrangements of lines used on prints to represent item of information.
- B. AWS - American Welding Society.
- C. ABBREVIATIONS - Shortened version of a word,
- D. ORHTOGRAPHIC DRAWING - Drawing using three views of an object in three small drawins.
- E. PICTORIAL DRAWING - Drawing showing three sides of an object in one drawing.
- F. NOTE - Lettered information concerning the details of construction.
- G. SPECIFICATION - When a note specifies the material required, the process used, type and size of electrode or other direct and specific information.

II. The three views of an orthographic drawing.

- A. Front
- B. Top
- C. Side

III. Two ways of showing dimensions on a drawing.

- A. Conventional dimensions
- B. Baseline dimensioning

IV. Types of lines used in welding drawings.

- A. Object line
- B. Hidden line
- C. Center line
- D. Extension and dimensional lines
- E. Leader line

INFORMATION SHEET

F. Cutting plane line

G. Short break line

H. Long break line

V. The two parts of the welding symbol.

A. Reference line

B. Arrow line

VI. The following elements can be applied to the welding symbol.

A. Fillet

B. Plug or slot

C. Spot projection

D. Seam

E. Square groove

F. V groove

G. U groove

H. J groove

I. Flare V groove

J. Flare bevel groove

K. Back or backing

L. Surfacing

M. Edge flange

N. Corner flange

O. Weld all around

P. Field weld

Q. Melt thru

R. Flush contour

S. Convex contour

T. Concave contour

VII. Significance of location of weld symbol on reference line.

A. If weld symbol is above reference line, weld is made on side opposite arrow.

B. If weld symbol is found below reference line, weld is to be made on arrow side.

VIII. Weld symbol elements that can be added to symbols.

A. Finish symbol

B. Contour symbol

INFORMATION SHEET

- C. Root opening, depth of filling for plug and slot welds.
- D. Size: size or strength for resistance welds.
- E. Specification, process or other reference.
- F. Tail
- G. Groove angle, included angle of counter sink for plug welds.
- H. Length of weld
- I. Field weld symbol
- J. Weld-all-around symbol
- K. Number of spot or projection welds
- L. Basic weld symbol

IX. Methods of attaining welding finishes used on welding symbols.

- A. C - Chipping
- B. G - Grinding
- C. M - Machining
- D. R - Rolling
- E. H - Hammering

X. Information found in the specification section of drawing.

- A. Quantity required
- B. Name of part
- C. Order number
- D. Date
- E. Number of the drawing
- F. Scale size used
- G. Drawn by

INFORMATION SHEET

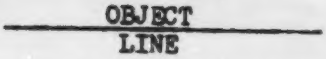
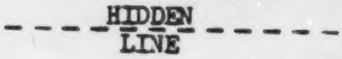
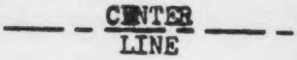
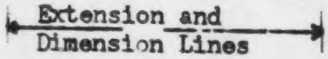
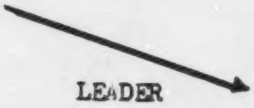
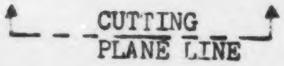
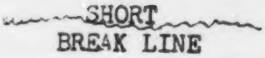
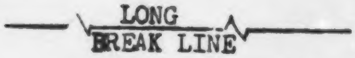
H. Material used

XI. Two types of abbreviations used in welding blueprints.

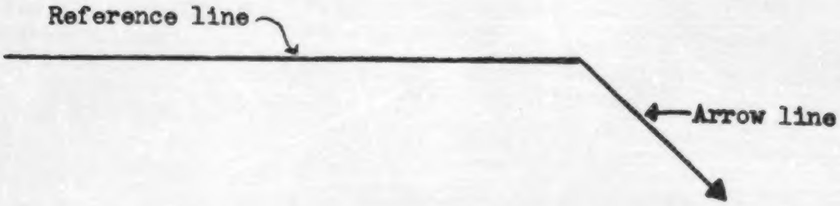
A. General abbreviations

B. Specific welding abbreviations

BASIC LINES

 OBJECT LINE	To show the visible shape of a part
 HIDDEN LINE	To show edges and outlines not visible to the eye
 CENTER LINE	To show the center of circles, arcs and symmetrical objects
 Extension and Dimension Lines	Extension lines show dimensioning points. Dimension lines touch the extension lines and show distance given by the dimensions
 LEADER	Points directly to a surface for the purpose of dimensioning or adding a note
 CUTTING PLANE LINE	To indicate where an imaginary cut is made through the object. The arrow points in the direction in which the section should be viewed.
 SHORT BREAK LINE	To show a short break(to conserve space on a drawing). To show a partial section
 LONG BREAK LINE	To show a long break (to conserve space on a drawing

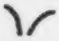
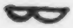
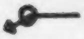
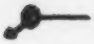
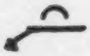
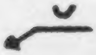
WELDING SYMBOL


Reference line
Arrow line

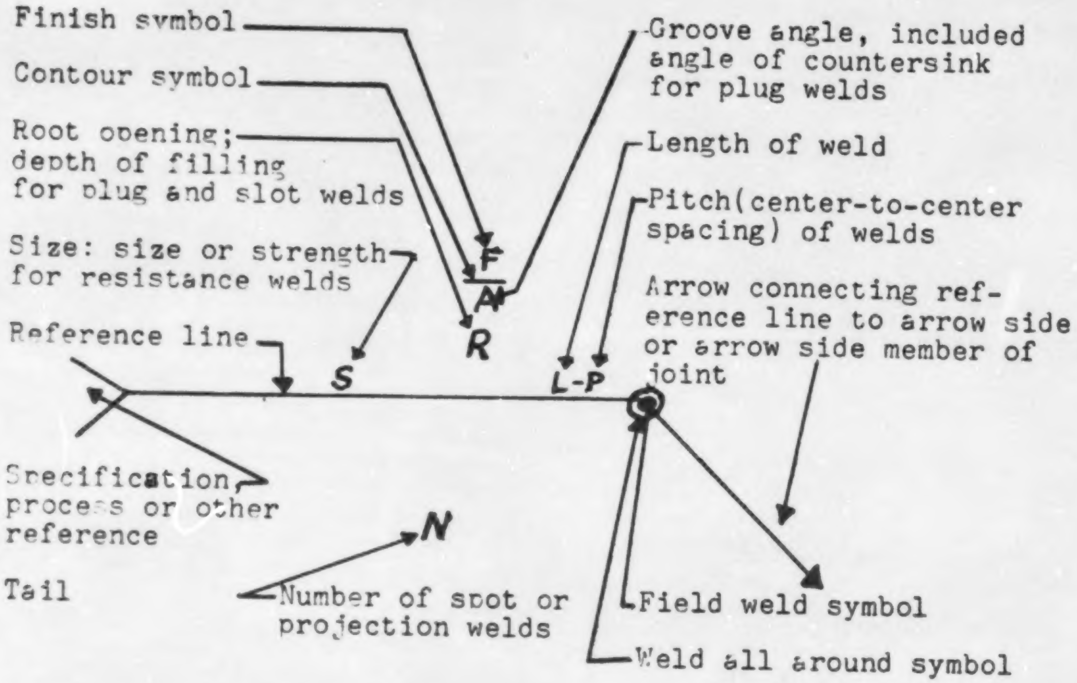
If weld symbol is located above the reference line the weld is to be made on side opposite of arrow.

If weld symbol is located below the reference line the weld is to be made on side arrow points to.

ELEMENTS APPLIED TO THE WELDING SYMBOL TO DENOTE VARIOUS WELDS

	FILLET
	PLUG OR SLOT
	SPOT OR PROJECTION
	SEAM
	SQUARE
	V GROOVE
	BEVEL GROOVE
	U GROOVE
	J GROOVE
	FLARE-V
	FLARE-BEVEL
	BACK OR BACKING
	SURFACING
	EDGE FLANGE
	CORNER FLANGE
	WELD ALL AROUND
	FIELD WELD
	MELT-THRU
	FLUSH CONTOUR
	CONVEX CONTOUR
	CONCAVE CONTOUR

ADDITIONAL WELDING SYMBOL ELEMENTS


Finish symbol
Contour symbol
Root opening; depth of filling for plug and slot welds
Size: size or strength for resistance welds
Reference line
Specification, process or other reference
Tail
Number of spot or projection welds
Groove angle, included angle of countersink for plug welds
Length of weld
Pitch(center-to-center spacing) of welds
Arrow connecting reference line to arrow side or arrow side member of joint
Field weld symbol
Weld all around symbol
F
A
R
S
L-P
N

GENERAL ABBREVIATIONS USED IN BLUEPRINTING

ABBREVIATION	SIGNIFICANCE
ASA	American Standards Association
AWG	
AWG	American wire gage
BWG	Birmingham wire gage
B&S	Brown & Sharpe
br#	Brass, SAE #
bro #	Bronze, SAE #
CI	Cast Iron
c to c	Center to center
chfr	Chamfer
cir	Circular
CRS	Cold rolled steel
c'bore	Counter bore
csk	Counter sink
cyl	Cylinder
deg. or °	Degree (s)
D	Diameter
diag.	Diagonal
fab	Fabricate
ft. or '	Foot, feet
V, fin, or f	Finish
ga	Gage
GI	Galvinized iron
hex	Hexagonal
I	I beam
thd	Thread

GENERAL ABBREVIATIONS USED IN BLUEPRINTING CONT.

ABBREVIATION	SIGNIFICANCE
ID	Inside diameter
" or in.	Inch (s)
LH	Left Hand
Mal I	Malleable iron
max	Maximum
min	Minimum
N	National Form (screw threads)
NC	National Coarse
NF	National Fine
# or no.	Number
OD	Outside Diameter
ox	oxide
pc,pcs	Piece (s)
P	Pitch
pl	Plate
# or lb	Pound
R	Radius
req	Required
RH	Right Hand
rd	Round
SAE	Society of Automotive Engineers
sq	Square
sq ft	Square Foot
Std	Standard
Stl	Steel
WI	Wrought Iron

WELDING ABBREVIATIONS

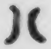
Letter Designation	Welding Process	Letter Designation	Welding Process
AAW	Air-Acetylene Welding	IRB	Infrared Brazing
AHW	Atomic Hydrogen Welding	IW	Induction Welding
BB	Block Brazing	LBW	Laser Beam Welding
BMAW	Bare Metal-Arc Welding	NTW	Nonpressure Thermit Welding
CAW	Carbon-Arc Welding	OAW	Oxyacetylene Welding
CW	Cold Welding	OHW	Oxyhydrogen Welding
DB	Dip Brazing	PAW	Plasma-Arc Welding
DFW	Diffusion Welding	PEW	Percussion Welding
DW	Die Welding	PGW	Pressure Gas Welding
EBW	Electron Beam Welding	PTW	Pressure Thermit Welding
EW	Electroslag Welding	RB	Resistance Brazing
EXW	Explosion Welding	RPW	Projection Welding
FB	Furnace Brazing	RSEW	Resistance-Seam Welding
FCAW	Flux Cored Arc Welding	RSW	Resistance-Spot Welding
FLB	Flow Brazing	RW	Roll Welding
FLOW	Flow Welding	SAW	Submerged Arc Welding
FOW	Forge Welding	SCAW	Shielded Carbon-Arc Welding
FRW	Friction Welding	SMAW	Shielded Metal-Arc Welding
FW	Flash Welding	SW	Stud Welding
GCAW	Gas Carbon-Arc Welding	TB	Torch Brazing
GMAW	Gas Metal-Arc Welding	TCAB	Twin-Carbon Arc Brazing
GSSW	Gas-Shielded Stud Welding	TCAW	Twin-Carbon Arc Welding
GTAW	Gas Tungsten-Arc Welding	TW	Thermit Welding
HW	Hammer Welding	USW	Ultrasonic Welding
IB	Induction Brazing	UW	Upset Welding

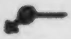
BLUEPRINT READING FOR WELDERS

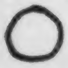
ASSIGNMENT SHEET #1 - IDENTIFICATION OF WELD SYMBOLS

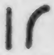
Name the following weld symbols.

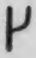
1.

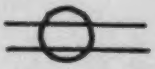
2. 

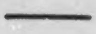
3. 

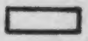
4. 

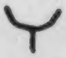
5. 

6. 

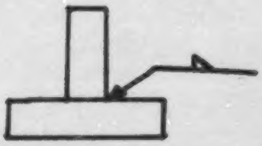
7. 

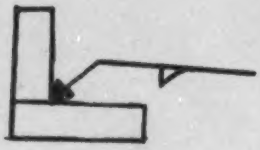
8. 

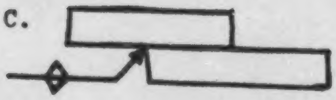
9. 

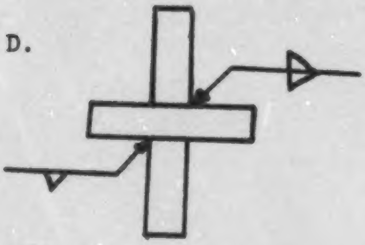
10. 

Place an "X" on the side weld is to be made in the following diagrams.

A. 

B. 

C. 

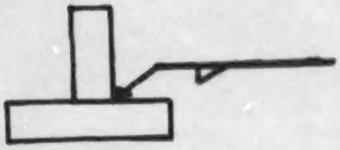
D. 

BLUEPRINT READING FOR WELDERS

ASSIGNMENT SHEET #2 - DESCRIBING WELD SYMBOLS

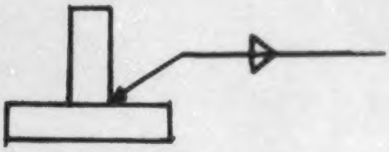
Describe the following weld symbols by indicating the side that weld is to be made on and type of weld.

1.



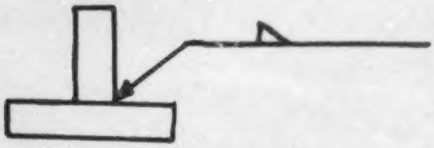
1.______________________________

2.



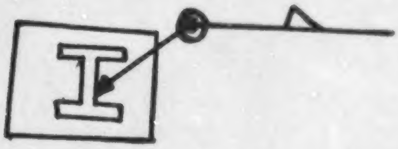
2.______________________________

3.



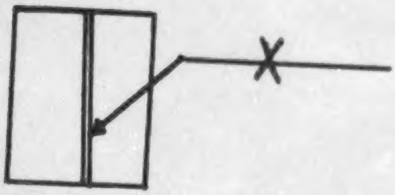
3.______________________________

4.



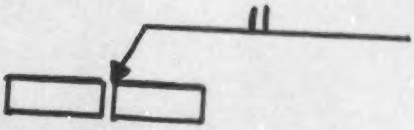
4.______________________________

5.



5.______________________________

6.



6.______________________________

BLUEPRINT READING FOR WELDERS

ASSIGNMENT SHEET #3 - INTERPRETING GENERAL ABBREVIATIONS

Interpret the following abbreviations.

A. NF

B. WI

C. B & S

D. ID

E. Stl

F. Od

G. CRS

H. CSK

I. GI

J. SAE

K. Bwg

L. # or No.

M. PL

N. I

O. lb.

P. Std

Q. Thd

R. Sq

S. LH

T. C to C

BLUEPRINT READING FOR WELDERS

ASSIGNMENT SHEET #4 - INTERPRETING WELDING ABBREVIATIONS

Identify the following welding abbreviations.

A. RPW

B. TB

C. GMAW

D. FOW

E. HW

F. IB

G. DB

H. AAW

I. SW

J. UX

K. FCAW

L. CAW

M. SMAW

N. DW

O. PAW

P. PGW

Q. CW

R. BMAW

S. TCAW

T. GTAW

BLUEPRINT READING FOR WELDERS

ASSIGNMENT SHEET #5 - GATHERING INFORMATION FROM A BLUEPRINT

Answer the questions below using the information from the two pages following.

1. How thick is the bottom head?____________________
2. How thick is the material used in the stack?__________
3. How thick is the skin of the tank?____________________
4. Give the dimensions of the sheet required for the:

   a. skin of the tank__________ b. the stack____________
5. What type of threaded fittings are used?______________
6. Give sizes and number of fittings used.______________
7. What is the diameter and length of stud?______________
8. What size and how many screw holes are used around the large hole?__________________________________
9. What is the size of distance F?______ or H?____________
10. How many inches and what type of weld is required to join the stack to the head at the top of the tank?______
11. What type of weld is required at point J?______________
12. What type of weld is used to join the hold down lug to the tank?__________________________________
13. How many hold down lugs are there?____________________
14. Do all these lugs require the same type of weld?________

    Explain your answer______________________________
15. What is the angle of G?____________________________
16. What is the distance from the top of the top head to the bottom of the bottom head?________________________
17. What is the dimension of A?____________ of E?__________

18. What is the distance from the bottom of the tank to the bottom of the hold down lugs?______________________

19. How many degrees apart are the hold down lugs?________

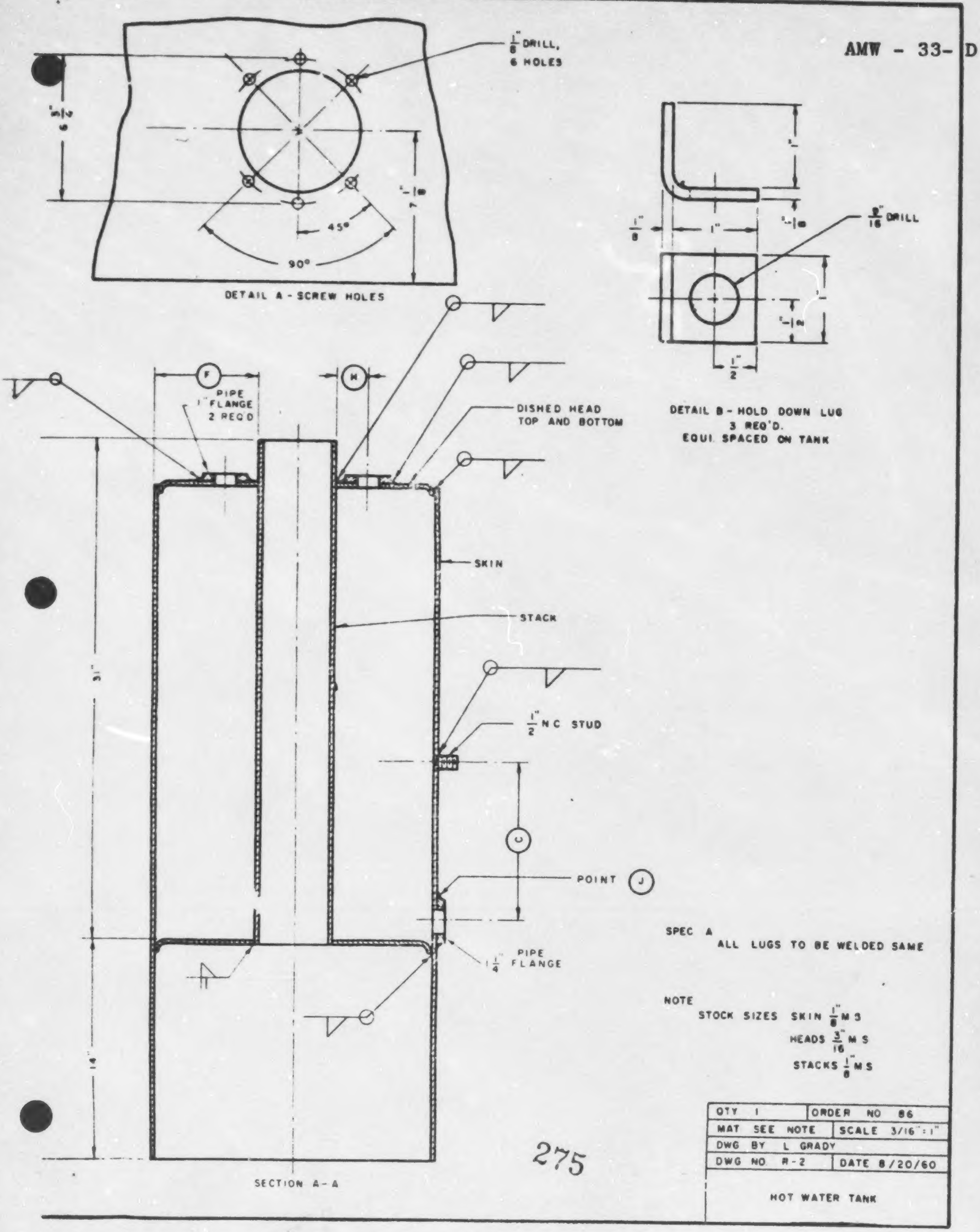
20. What types of welds are required to join the stack to the bottom of the tank?_______________________________

21. What is the inside diameter of the tank?_____________

22. Make a list of materials required for the fabrication of the tank (give all sizes)._______________________

23. What is the approximate combined length of all welds required on the tank? (Omit welds on flanges, lugs and studs)____

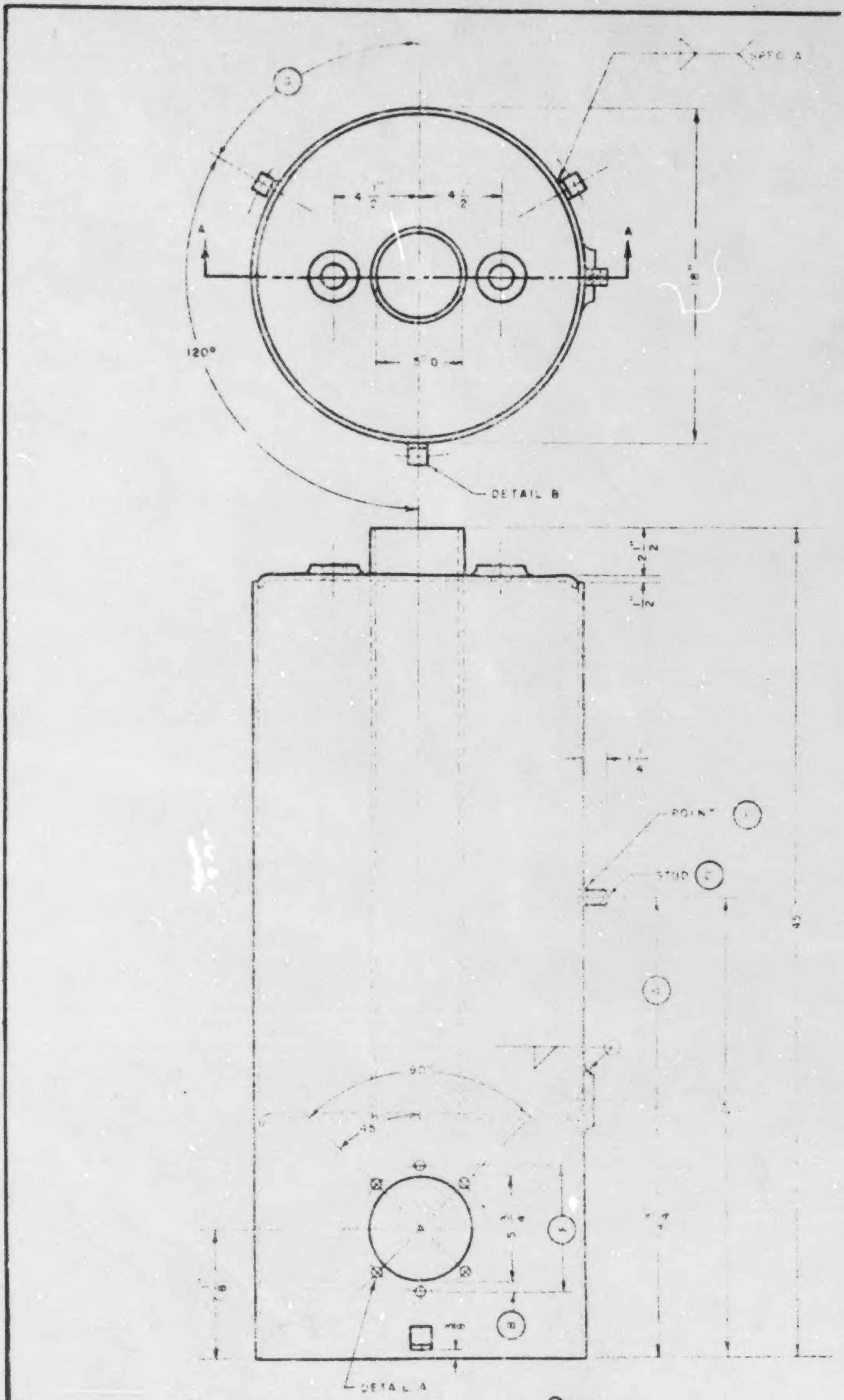
ASSIGNMENT SHEET #5 - GATHERING INFORMATION FROM A BLUEPRINT


AMW - 33- D
1/8" DRILL, 6 HOLES
2 5/8"
7 1/8"
45°
90°
DETAIL A - SCREW HOLES
1"
1/8"
1"
1/8"
9/16" DRILL
1"
1/2"
1/2"
DETAIL B - HOLD DOWN LUG 3 REQ'D. EQUI. SPACED ON TANK
F
H
PIPE 1" FLANGE 2 REQ'D
DISHED HEAD TOP AND BOTTOM
SKIN
STACK
31"
1/2" N C STUD
C
POINT J
1 1/4" PIPE FLANGE
14"
SECTION A-A

SPEC A
ALL LUGS TO BE WELDED SAME

NOTE
STOCK SIZES SKIN 1/8" M S
HEADS 3/16" M S
STACKS 1/8" M S

QTY 1	ORDER NO 86
MAT SEE NOTE	SCALE 3/16" : 1"
DWG BY L GRADY	
DWG NO R-2	DATE 8/20/60
HOT WATER TANK	


SPEC. A
4 1/2
4 1/2
A
A
16"
120°
5" D
DETAIL B
2 1/2
1/2
1/4
POINT
STUD
45
90°
45°
DETAIL A

BLUEPRINT READING FOR WELDERS

ANSWERS TO ASSIGNMENT SHEETS

Assignment sheet #1

1. V groove
2. Edge flange
3. Weld all around
4. Spot or projection weld
5. Bevel groove
6. J groove
7. Seam
8. Flush contour
9. Plug or slot weld
10. V groove weld

A. Fillet weld side away from arrow

B. Fillet weld on arrow side

C. Fillet weld both sides

D. Fillet weld both sides

Assignment sheet #2

1. From arrow fillet weld on arrow side
2. Fillet weld on both sides
3. Fillet weld on other side
4. Fillet weld, welded all around in the field
5. V groove welded on both sides
6. Flash weld

Assignment sheet #3

A. National fine

B. Wrought iron

C. Browne and Sharpe

D. Inside diameter

E. Steel

F. Outside diameter

G. Cold rolled steel

H. Counter sink

I. Galvanized iron

J. Society of automotive engineers

K. Birmingham Wire Gauge

L. Number

M. Plate

N. Ibeam

O. Pound

P. Standard

Q. Threads

R. Square

S. Left hand

T. Center to center

Assignment sheet #4

A. Projection welding

B. Torch blazing

C. Gas metal arc welding

D. Forge welding

E. Hammer welding

F. Induction brazing

G. Dip brazing

H. Air-acetylene welding

I. Stud welding

J. Upset welding

K. Flux cored arc welding

L. Carbon-arc welding

M. Shielded metal arc welding

N. Die welding

O. Plasma arc welding

P. Pressure gas welding

Q. Cold welding

R. Bare metal arc welding

S. Twin carbon arc welding

T. Gas tungsten arc welding

Assignment sheet #5

1. 3/16" mild steel
2. 1/8" mild steel
3. 1/8" mild steel
4. Skin - 42" X 66½" Stack - 31" X 15.7"
5. Studs, pipe flange
6. ½" NC stud 1¼" long, 1¼" pipe flange, 2-1" pipe flange
7. ½" to 1¼"
8. 6 - 1/8" holes
9. 6 3/8" 2 3/8"
10. Fillet weld 15.7" long
11. Fillet weld
12. Fillet weld on both sides
13. 3
14. Yes Specification A
15. 60°
16. 28 7/8"
17. 10½"
18. 3/8"

19. 120°
20. Fillet and flash or upset weld
21. 17 3/4"
22. 1/8" X 42 X 66½" MS, 3/16" X 18" X 36" MS, 1/8" X 31" X 15.7"
    2-1" pipe flange, 1-¼" pipe flange, 1½" X 1¼" NC stud
    3-1/8" X 1" X 2" MS
23. Approximately 150 inches

BLUEPRINT READING FOR WELDERS

TEST

I. Match the terms listed below to the correct definition.

___1. American Welding Society

___2. Shortened version of a word.

___3. Drawing showing three sides of an object in one drawing.

___4. Characters of arrangement of lines used on prints to represent item of information.

___5. Lettered information concerning the details of construction.

A. Pictorial Drawing

B. AWS

C. Symbols

D. Abbreviations

E. Note

II. Identify the three views of an orthographic drawing.

A.

B.

C.

III. Name the two ways of showing dimensions on a drawing.

A.

B.

IV. Choose from the following list, the types of lines used in welding drawings.

___A. Hidden line

___B. Base line

___C. Leader line

___D. Front line

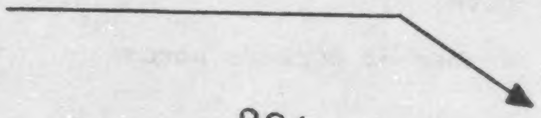
___E. Object line

___F. Short break line

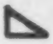
___G. Center line

___H. Extension line

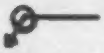
V. Identify two parts of the welding symbol shown below.

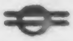


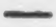
VI. Match the welding symbol on the left to the correct name listed on the right.

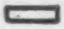
___1.  A. U groove weld

___2. B. Weld all around

___3.  C. Plug or slot

___4.  D. Flush contour

___5.  E. Fillet weld

___6.  F. Seam weld

VII. Describe the significance of the location of the weld symbol on the reference line.

VIII. List five weld symbol elements that can be added to weld symbol.

A.

B.

C.

D.

E.

IX. List four methods of attaining weld finishes used on welding symbols.

A.

B.

C.

D.

X. Choose from the following list, four pieces of information found in the specification section of a drawing by placing an "X" in the correct blank.

___A. Scale size used

___B. Location of job

___C. Date

___D. Number of workers needed

___E. Material used

___F. Name of part

XI. List the two types of abbreviations used in welding blueprints.

A.

B.

BLUEPRINT READING FOR WELDERS

ANSWERS TO TEST

I.
1. B
2. D
3. A
4. C
5. E

II.
A. Front
B. Side
C. Top

III.
A. Conventional dimensions
B. Baseline dimensioning

IV. An "X" should be in blanks A,C,E,F,G and H.

V.
A. Reference line
B. Arrow line

VI.
1. E
2. A
3. B
4. F
5. D
6. C

VII.
A. If weld symbol is above reference line, weld is made on side opposite arrow.
B. If weld symbol is found below reference line, weld is to be made on arrow side.

VIII.
A. Finish symbol
B. Contour symbol

C. Root opening, depth of filling for plug and slot welds.

D. Size: size or strength for resistance welds

E. Specification, process or other references

F. Tail

G. Groove angle, included angle of contour sink for plug welds.

H. Length of weld

I. Field weld symbol

J. Weld-all-around symbol

K. Number of spot or projection welds

L. Basic weld symbol

IX. Any four of the following:

A. C - Chipping

B. G - Grinding

C. M - Machining

D. R - Rolling

E. H - Hammering

X. An "X" should be in blanks A,C,E and F.

XI. A. General abbreviations

B. Specific welding abbreviations

JOB OPPORTUNITIES IN AG METALS

UNIT I

SECTION E

AG METALS AND JOB OPPORTUNITIES

TERMINAL OBJECTIVE

After completion of this unit, the student should be able to describe several job opportunities related to ag metals. This knowledge will be evidenced by scoring at least eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

I. Match terms associated with ag metals to the correct definition.

II. List six areas of work in the ag metals field.

III. List and describe the job requirements of six areas of ag metal jobs.

IV. List and describe the job characteristics of six areas in the ag metal field.

V. List fifteen factors to be considered before choosing an occupation.

VI. List four steps of job advancement.

VII. List three factors which determine the speed of advancement.

VIII. List ten jobs in ag metal areas.

AG METALS AND JOB OPPORTUNITIES

SUGGESTED ACTIVITIES

I. Instructor:

  A. Provide students with objectives.

  B. Provide students with information sheets.

  C. Discuss terminal and specific objectives.

  D. Discuss information sheets.

  E. Give test.

II. Student:

  A. Read objectives.

  B. Study information sheets.

  C. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

  A. Objective sheet

  B. Information sheet

  C. Transparency masters

    1. TM 1 - Occupational Information

  D. Test

  E. Answers to test

II. References:

  A. Althouse, Turnquist and Bowditch, Modern Welding, Homewood, Illinois, The Goodheart Wilcox Co.

  B. U.S. Department of Labor, Occupational Outlook Handbook, 1978-79 Edition, Washington, D.C. U.S. Government Printing Office.

AG METALS AND JOB OPPORTUNITIES

INFORMATION SHEET

I. Terms and definitions:

A. ARC WELDING - The term used to describe the process of joining two pieces of metal together by the heat produced by an electric arc.

B. SHEET METAL - Metal ¼" or less in thickness.

C. OXYGEN-ACETYLENE WELDING - A method of welding, using as a fuel a combination of the two gases oxygen and acetylene.

D. AUTOMATIC WELDING - Welding in which the work, the torch and/or the arc is mechanically moved and controls arc used to control the speed and/or the direction of travel.

E. GAS METAL ARC WELDING - Welding using a continuously fed consumable electrode and a shielding gas.

II. Areas of work in the ag metal field.

A. Construction welding (buildings or bridges)

B. Aircraft and shipbuilding welding

C. Steel manufactor (automobile, railroads or general steel)

D. Petroleum pipe welding

E. Private shop welding

F. General shop repair and farm maintenance

III. Job requirements:

A. Construction welding

1. Must be a certified welder.

2. Blueprint reading might be helpful.

3. Experience training in arc welding and gas welding equipment.

4. Ability to move with the jobs.

INFORMATION SHEET

5. Ability to weld to meet company and government requirements.

B. Aircraft and shipbuilding welding

1. Must be a certified welder.

2. Must have the ability to weld in a group with or at a certain speed.

3. Ability to read blueprint or mechanical drawing.

4. Experience with different types of welding equipment.

C. Steel manufactor.

1. Must be a certified welder.

2. Ability to weld in and with a group.

3. Ability to read mechanical drawings.

4. Experience training with gas and arc welding.

5. Ability to weld in any position.

D. Petroleum pipe welding.

1. Must be a certified welder.

2. Must have the ability to weld any size, in any direction and any type of pipe.

3. Experience required in gas and arc welding.

E. Private shop welding.

1. Must be a certified welder.

2. Must have the ability to meet the public.

3. Experience with gas and arc welding.

4. Must have the ability to keep a good shop.

F. General shop repair and farm maintenance.

1. Must have the ability to weld in any position.

2. Must have the experience with gas and arc welding.

3. Courses in shop maintenance may be helpful.

INFORMATION SHEET

4. Must have the ability to keep up and maintain good shop and welding equipment.

5. Must have the ability to weld in different sizes and any type of metal.

IV. Job characteristics.

A. Construction welding.

1. Must be able to travel with the job.

2. Must have the ability to weld indoors and outdoors.

3. Must be able to weld at very high heights.

4. Sometimes work may be very long hours.

B. Aircraft and shipbuilding welding.

1. Welding maybe outdoors and indoors.

2. Must be able to weld within a group.

3. Blueprinting and mechanical reading may be required.

4. Welding must pass government inspection.

C. Steel manufactor.

1. Welding must pass government inspection.

2. Welding may be outdoors or indoors.

3. Must be good health for steady work.

4. Mostly the working hours will be regular.

D. Petroleum pipe welding.

1. Welding will be mostly outdoors work.

2. Welding may be in groups or individual welding.

3. Welding might involve traveling.

INFORMATION SHEET

E. Private shop welding.
    1. Ability to meet public demand.
    2. May be mostly indoors welding.
    3. Ability to be your own boss.
    4. Enjoying welding at your own work.
F. General shop repair and farm maintenance.
    1. Welding may be indoors or outdoors.
    2. Must know skills concerning shop work and farm work.
    3. Must have the ability to work with farm equipment and tools.

V. Factors to consider before choosing an occupation.
    A. Does the occupation require chiefly mental or physical effort?
    B. What is your condition of health?
    C. Do your personal qualifications qualify you for a job in ag metals?
    D. Is the work inside, outside or both?
    E. What are the working conditions?
    F. What are the educational and training requirements for the job?
    G. What is the nature of work? What kinds of jobs will I be expected to do?
    H. Is there opportunity for doing a variety of jobs?
    I. What financial earnings can one expect?
    J. Are any fringe benefits provided by the job?
    K. Is there a great deal of risk involved in performing the job?
    L. Are there opportunities for advancement and self betterment?

INFORMATION SHEET

- M. Do you work regular hours? Day or night shift?
- N. Is there stability of residence?
- O. Will you work alone with others?

VI. Steps of job advancement.

- A. General welder
- B. Head welder
- C. Head maintenance
- D. Maintenance supervisor or manager

VII. Factors which determine the speed of advancement.

- A. Education
- B. Type of job
- C. Type of experience

VIII. Jobs in the ag metals field.

- A. Shipbuilding
- B. Aircraft welding
- C. Construction welding
- D. American steel construction
- E. General shop welding
- F. Shop supervisor
- G. Sheet metal
- H. Aluminum industry
- I. American railroads company
- J. Private shop welding

OCCUPATIONAL INFORMATION

JOB	REGULAR INCOME	REGULAR HOURS	OUTDOOR OR INDOORS	VARIETY	WORK WITH OTHERS	STABILITY OF RESIDENCE	FRINGE BENEFITS
Construction Welding	Yes	Yes	Both	Yes	Yes	Sometimes	Yes
Aircraft & Shipbuilding Welding	Yes	Yes	Both	Yes	Yes	Yes	Yes
Steel Manufactor	Yes	Yes	Both	Yes	Yes	Yes	Yes
Petroleum Pipe Welding	Yes	Yes	Outdoors	No	Yes	Sometimes	Yes
Private Shop Welding	Yes	Yes	Indoors	Yes	No	Yes	None
Shop Repair & Farm Maintenance	Yes	Yes	Both	Yes	No	Yes	None

AG METALS AND JOB OPPORTUNITIES

TEST

I. Match the terms below to the correct definition.

A. Method of welding with a combination of two gases.

B. Metal ¼" or less in thickness.

C. Welding equipment in which the work, the torch and/or the arc is mechanically moved and controls arc used to control the speed and/or the direction of travel.

D. Joining two pieces of metal together by the heat produced by an electric arc.

E. Welding using a continuously fed consumable electrode and a shielding gas.

___1. Sheet Metal

___2. Arc Welding

___3. Automatic Welding

___4. Gas Metal Arc Welding

___5. Oxygen Acetylene Welding

II. List six areas of work in the ag metals field.

A.

B.

C.

D.

E.

F.

III. List and describe the job requirements of six areas of ag metal jobs.

A.

B.

C.

D.

E.

F.

IV. List and describe the job characteristics of six areas in the ag metal field.

A.

B.

C.

D.

E.

F.

V. List fifteen factors to be considered before choosing an occupation.

A.

B.

C.

D.

E.

F.

G.

H.

I.

J.

K.

L.

M.

N.

O.

VI. List four steps of job advancement.

A.

B.

C.

D.

VII. List three factors which determine the speed of advancement.

A.

B.

C.

VIII. List ten jobs in the ag metal field.

A.

B.

C.

D.

E.

F.

G.

H.

I.

J.

AG METALS AND JOB OPPORTUNITIES

ANSWERS TO TEST

I. 1. B

2. D

3. C

4. E

5. A

II. A. Construction welding

B. Aircraft and shipbuilding welding

C. Steel manufactor

D. Petroleum pipe welding

E. Private shop welding

F. General shop repair and farm maintenance

III. To the satisfaction of the instructor.

IV. To the satisfaction of the instructor.

V. A. Does the occupation require chiefly mental or physical effort?

B. What is your condition of health?

C. Do your personal qualifications qualify you for a job in ag metals?

D. Is the work inside, outside or both?

E. What are the working conditions?

F. What are the education and training requirements for the job?

G. What is the nature of work? What kind of jobs will I be expected to do?

H. Is there opportunity for doing a variety of jobs?

I. What financial earnings can one expect?

J. Are any fringe benefits provided by the job?

K. Is there a great deal of risk involved in performing the job?

L. Are there opportunities for advancement and self betterment?

M. Do you work regular hours? Day or night shift?

N. Is there stability of residence?

O. Will you work alone or with others?

VI. A. General welder

B. Head welder

C. Head maintenance

D. Maintenance supervisor or manager

VII. A. Education

B. Type of job

C. Type of experience

VIII. A. Shipbuilding

B. Aircraft welding

C. Construction welding

D. American steel construction

E. General shop welding

F. Shop supervisor

G. Sheet metal

H. Aluminum industry

I. American railroads company

J. Private shop welding